SYSTEMS RESEARCH INSTITUTE

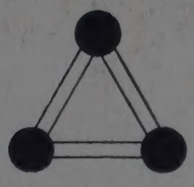
POPSIM : A POPULATION SIMULATION MODEL OF INDIA

A Study Commissioned by the
FAMILY PLANNING FOUNDATION OF INDIA
to Analyse the Medium and Long Term
Demographic And Socio-economic Implications
of Raising Female Age at Marriage

by

K N S Nair and J G Krishnayya

R-1983.1-MOD May 1983



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PREFACE

We are happy to be able to present this brief Report on the work done at SRI under a Study commissioned by the Family Planning Foundation of India under the title "Socio-economic Determinants of Age of Female at Marriage and its Effect on Fertility Behaviour in India". What will become clear from the material that follows is that age-at-marriage is itself a complex phenomena, and is one of many inter-related socio-economic phenomena which must be studied together in terms of their effect on the birth rate.

A comprehensive and wholistic analysis of the determinants of the age-at-marriage is described in this Report and after linking them with the IBN model, we report extensively the impact of increased literacy rates, especially female literacy in rural areas, and the impact of increased school enrolment, on age-at-marriage and on fertility. The results seem to indicate that the demographic and economic results of a serious effort to increase school relevance and attendance, coupled with an intense social education cum literacy campaign for adult women in rural and urban areas would result in an economic "take-off" within a few years. The increased per capita private expenditure on basic needs that correlates with these results indicates a simultaneous improvement in the quality of the population which is another happy outcome of such a positive strategy. The four strategies presented here all make clear that a continuation of the family-size limitation programme of the government must undergird all other components of a population policy.

The exercises are but the first of many that can be based upon POPSIM, the extended demographic and population model built in the course of this research commissioned by the Family Planning Foundation of India, which was based on work supported by the ICSSR to add major labour force

participation and education and migration dimensions to the earlier IBN model built in 1980-81 with help from the ILO. In fields, like demography, where the variables have great linkages with variables in other dimensions of the system, it appears to be more useful to study a given topic with the help of a comprehensive model than to attempt a partial or isolated analysis. We would like to acknowledge our debt to Prof J C Kavoori, Executive Director of FPFI who encouraged us to go ahead with this work and was patient with us through the delays caused by computer malfunctions.

This research project was visualised and carried out by Dr K N S Nair with the enthusiastic and dedicated help of Dr V Phaneendhrudu. It could not have been done without the existence of the SRI Computer Centre with the interactive HP/1000 computer and with the software support for modelling created earlier by S Siddiqui. The computer-generated graphs are due to the SRI Unigraphics software created in 1983 by Mr Umesh Deo. We thank Mr P Kannan for rapid preparation of the typescript and stencils.

- J G Krishnayya
Executive Director

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CHAPTER 1

INTRODUCTION AND SUMMARY OF FINDINGS

India ranks in the top ten industrialised countries of the world. It has abundant natural resources and a large army of skilled technical manpower. Technological development is fast catching up in the industrial and service sectors. Indeed, the rapid progress of the Indian industries during the post-independent period in terms of technological breakthroughs as well as diversification is an exceptional achievement for a developing country under colonialism for over two centuries.

However, such spectacular achievements relate to specific sectors and are concentrated in large cities with the result that modern and traditional India exist side by side. A large proportion of the people living in rural areas are still deprived even of some of the basic human needs such as adequate food, drinking water, education, health care, transport and communication facilities and employment. Even when such facilities are made available, often they bypass target groups due to the prevailing unjust remnants of an old system. Of late, the government has realised the gravity of the situation and has started a number of schemes such as IDRP, ITDP, DPAP, etc. which various financial and administrative agencies are supposed to implement in a coordinated manner with the active participation of the target groups. These steps should improve, at least marginally, the poignant condition of the rural poor.

However, the real block in the way of faster socio-economic development of the country is its sizable and growing population. The course of planned development during the past three decades substantiates this. The colourful achievement at the aggregate level in agriculture and industry has been, to a large extent, over-shadowed by the ever growing population. The country may have potential to produce enough food even to feed twice the present population, but that is not an argument to allow the population to grow when such potentials cannot be realised within the foreseeable future and not at any reasonable cost! Thus a comprehensive population policy is a 'sine qua non' to immediately arrest its growth and also to improve its quality.

1.1 Outline of the Present Study

The 1981 census results made even the expert projections on population growth to go awry. This was inspite of the massive expenditure on the family planning programmes during the seventies. This has also resulted in the general thinking that a package of programmes rather than any single programme may be more efficient nnd effective towards controlling the population. Raising the average age at marriage appears to be a promising factor to control the population growth. However, since age at marriage is interconnected with various other socio-economic factors (literacy, school enrolment rates, etc), studying the effect of raising age at marriage alone on the population may be incomplete and misleading. Hence it was proposed to develop a general population simulation model involving age at marriage (rather, the percentage of girls/women married in different age groups), agewise effective marital fertility rate, percentage of women protected by family planning methods (agewise) and associated socio economic factors such as education, labour force, enrolment rates, per capita income etc. for rural and urban areas separately.

1.2 Female Age at Marriage

The female age at marriage depends upon cultural norms, social values, her biological maturity for sexual life, and on her economic independence and status in the society. In earlier days child marriages were a common phenomenon and the Child Marriage Restrain Act of 1929 in British India was the first legal step to check this custom of child marriage. Undoubtedly this had some effect. In 1955 the Hindu Code was revised and this sought to establish the minimum age at marriage to be 15 instead of 14 as earlier set by the Sharada Acts.

Shifts in age at marriage for the females in India for the period 1931-1971 can be seen through the proportion of females remaining single in the age groups 10-14 and 15-19 and through the mean age at marriage. (Source Pathak, 1980; Agarwala, 1974)

Year	1931	1941	1951	1961	1971
Mean age at Marriage	14.9	15.4	15.4	16.1	17.2
Proportion of singles: 10-14	.493	.755	.827	.834	.881
15-19	.166	.252	.280	.292	.429

In India, the mean age at marriage for women is quite low as compared to other countries. It is also interesting to note that while the minimum age at marriage for women in most countries lies below or is the same as that in India, marrying late is in vogue in those countries, in contrast to the practice of marrying early in India. There can be many a reason for this phenomenon. It is, therefore, worthwhile to study and analyse the possible factors responsible for the practice of marrying at an early age in India.

In China, raising the age of females at marriage has seemed to be very effective in reducing the fertility rate. This is due to (1) a reduction in the reproductive span of females, (2) it may be related to better schooling and work force participation rates, thereby reducing their desired family size, (3) it leads to better maternal care, thus lowering the incidence of infant mortality which may affect the fertility behaviour, and (4) a qualitative change (better education, labour force participation etc.) in the population in the lower age groups which could lead to their higher acceptance of family planning.

1.3 Objective of the Current Study

The Systems Research Institute, with financial support from the International Labour Organisation, Geneva, has during 1979-81 developed a computer simulation model - "India Basic Needs (IBN) : A Socio-economic and Demographic Simulation Model" which takes into account explicitly the inter-relationships among different demographicand socio-economic variables. (For full details of the model please refer to India Basic Needs Model, WEP 2-32/WP-25, 1981, ILO, Geneva; also published in 1981 by Systems Research Institute, Pune 37.)

The IBN Model will be used specifically to

(i) Isolate and identify various socio-economic factors affecting female age at marriage at the all-India level;

(ii) Ascertain the demographic and economic impact of raising the female age at marriage and also on employment;

(iii) Develop new equations and by using the Systems Research Institute's Basic Needs Model to illustrate various scenarios generated by raising female age at marriage to various alternative levels;

(iv) Spell out the short and long-term perspectives and demographic and socio-economic implications of raising age at marriage of females pertaining to the period 1980-2000 . The model envisages working out solutions for one year at a time.

(v) Attempt also to evolve guidelines for population policies concerning impact of raising female age at marriage on fertility rates, per capita income, employment, etc.; and

(vi) Demonstrate how social scientists can use systems simulation models as a means of incorporating fresh information as "building blocks" into previous work to construct policy analysis of complex socio-economic and demographic subsystems.

This requires (a) specification and estimation of a submodel of 'female age at marriage and fertility behaviour', (b) interfacing it with the IBN model and (c) simulating it for selected policy alternatives.

1.4 Summary of Findings

POPSIM was simulated from 1971 to 2000 to obtain the base run scenario (i.e., a projection of the system without any policy changes to see what happens if the present policies continue). This formed a basis for comparing the results obtained by simulating the alternative strategies. The base run results show a gloomy picture of the socio-economic and demographic conditions in 2000 mainly due to population growth. The achievement at aggregate

level appears to be impressive in 2000 but the population of over a billion persons considerably dilutes it at the per capita level.

The following four strategies were simulated on POPSIM to evaluate their effect on population and on other demographic variables as well as on the general socio-economic system.

(i) India achieves Kerala's 1971 pattern of age-at-marriage by 1990
(ii) Raising school enrolment rates for India by 1990 to the level reached by Tamil Nadu, Punjab and Kerala in 1981
(iii) India achieves the 1971 Kerala literacy rates in 1990
(iv) School enrolment rates as in Strategy 2 along with somewhat better literacy rates

A comparison of simulated results with those of the base run reveals that the direct control of age at marriage (e.g. by effective legal measures) can bring only limited reduction in the population growth besides generating a lot of social tensions. On the other hand a rise in the age at marriage, if brought about by controlling certain related factors like literacy and education could curtail the population growth more effectively. It would be noted that the two strategies are qualitatively different. Strategy one is artificial in nature while strategies two and four already lie on the natural growth path, but they reach the targets in a shorter period. The basic difference between them is that under strategies two and four, girls could take advantage of the additional years they are getting due to the delayed marriage.

Under strategies two to four the economy grows rapidly: this is also reflected in its structural transformation, measured by the changing share of sectoral outputs and the pattern of allocation of household expenditure on food, manufacturing and services.

In general, strategies two to four point towards the fact that the key to India's socio-economic development lies in the control of its growing population. Undoubtedly, family planning is the number one strategy to deal with this problem.

However, even assuming an optimistic share of couples protected by different family planning methods (graph sheet no. 5.1) it is estimated that India's total population is likely to cross the billion mark by 2000 A.D. An enhanced family planning programme could of course, form a potential strategy to deal with this situation, but is by no means the most effective one. For, part of the problem is caused by the fact that the percentage of married women protected by family planning methods is too low in the lower age groups and if past trends are any indication, then this will even decline further.

1.5 Suggested Further Work

POPSIM assumes all factors associated with family planning (such as type of method, annual target for different methods, age-wise distribution of additional married women protected under different methods, etc) to be exogeneous. However, raising age at marriage is likely to have some complementary affects on the general acceptance and age-wise distribution of acceptors. Hence it would be preferable to make some of these variables endogeneous to the system by specifying and estimating additional behavioural equations and adding them to POPSIM. It may be necessary to collect primary data to estimate some of these equations as the relevant data is not today available at the national level.

Even in its present form POPSIM has great potential to evaluate a variety of strategies related to age at marriage, fertility behaviour and family planning. The strategies described in chapter five are only suggestive and by no means exhaustive. The model is quite flexible, and can be used to try a combination of different strategies which may start and end at different points in time, with differing growth rates and additional controls etc.

Examples of some of the strategies which can be evaluated with POPSIM besides those related to age-at-marriage are:

(i) Effect of a given target for a particular method on the population growth.

(ii) Alternatively, to achieve a specific growth rate of population how much the target for each of the methodshas to be increased. For example, is it feasible to limit the population size to 900 million and if so what should be the annual targets for different family planning methods?

(iii) Implications of changes in the age distribution of women protected by different methods.

(iv) Demographic and economic implications of 'one/two children family norm' if implemented.

Finally POPSIM can be suitably modified and estimated to be useful on a regional basis such as for a group of states or for specific states to evolve suitable population policies for that region. This is all the more important for a country as diverse as India in terms of resources, culture, language, and even social attitude and outlook. National policies ought to be suitably modified to suit the local conditions to make them efficient and effective.

CHAPTER 2

IBN : THE INDIA BASIC NEEDS MODEL
A LARGE SCALE COMPUTER SIMULATION MODEL FOR POLICY ANALYSIS

2.1 Relevance of the Model

Lack of clarity about, and understanding of, various socio-economic and demographic factors and their inter-relationships leads to misconceptions and sometimes to the pursuit of wrong or untimely policies. Because many of the issues in developmental studies are empirical in nature, wide options should be available to test a variety of hypotheses and to select the ones which are empirically consistent.

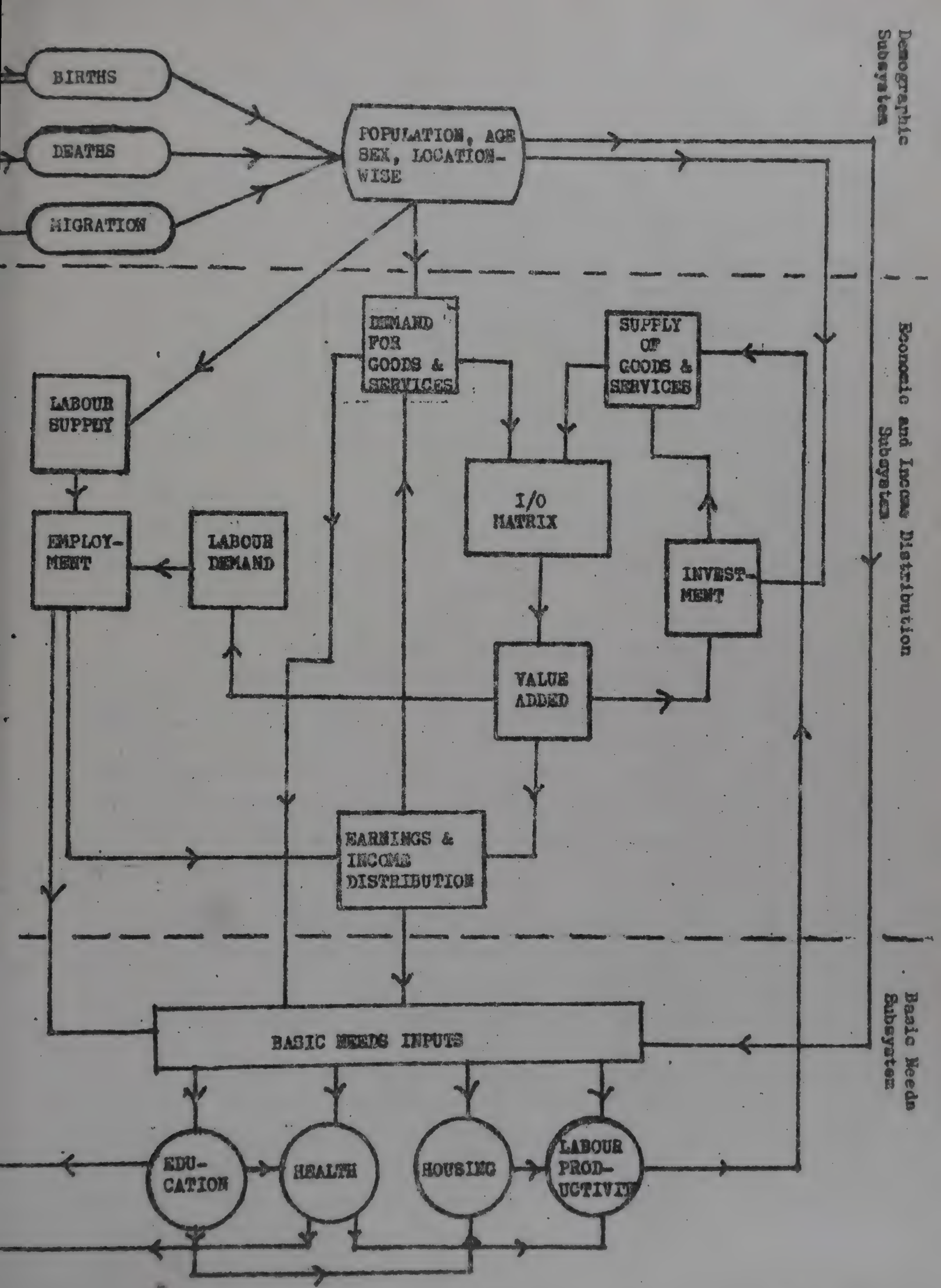
That there has been a general failure of the earlier plan models is now accepted, and this has clearlypointed to the need to approach policies from a systems point of view rather than to use a partial approach because the factors - dualistic nature of the economy, population growth, sectoral linkages, rigid income distribution - are so interrelated. In this respect a systems simulation model is more and more used as an appropriate tool.

With a properly structured simulation model one can test alternative policies and evolve optimum strategies to achieve certain targets. Their effects can be studied over a period of time under a variety of assumptions about external conditions and the policies tuned accordingly. Thus systems simulation models are becoming firmly established as an integral part of the planning and development process, especially in the developing countries.

2.2 Structure of the India Basic Needs Model.

The model is primarily meant to simulate socio-economic and demographic factors on a yearly basis over a long period. The period of simulation has been taken as thirty years from 1970-71 to 2000-2001, though this can be reduced or extended for specific purposes.

The structure of the model can be broadly understood as consisting of six subsystems namely: (1) Demographic, (2) Education, (3) Labour Supply, (4) Economic, (5) Income Distribution and (6) Basic Needs Satisfaction.



An Overview of the Model.

In figure 2.1 we present a schematic overview of the model with the main interrelationships of the demographic, economic and basic needs sybsystems.

(1) Demographic Subsystem: The demographic subsystem consists of disaggregated population, labour force participation rates, crude birth rate, migration propensity, etc. The disaggregation of population into rural and urban, male and female and into 5-year age groups is very useful in analysing factors related to the composition of population. For example many of the socio economic and demographic variables such as enrolment rates, labour force participation rates, fertility rates and dependency rates are influenced by the agewise distribution of the population. Net migration in different age groups from rural to urban areas is also very important in studying the growth of population and employment in rural and urban areas.

Propensity to migrate is to a large extent caused by regional imbalances and differential growth rates of regions. In the present model, regions have been differentiated only in terms of "rural" and "urban"; the net migration propensity from rural to urban is considered.

An overview of the demographic subsystem is presented in figure 2.2. In this subsystem the model endogenously predicts crude birth rate, female labour force participation rate and the propensity of rural populations to migrate to urban areas. Though it is desirable to estimate labour force participation rates for rural and urban populations and for specific age groups, for various reasons only the overall female labour force participation rate has been estimated. The male labour force participation rate is assumed to be constant over time.

Female life expectancy at birth is estimated (as a behavioural equation in the Basic Needs subsystem) and using Coale-Demeny tables the life expectancy of males, and the survival probabilities are obtained. Using these probabilities the agewise, sexwise projection of the population is done.

(2) & (3) Economic and Income Distribution Subsystem: Various production and service activities in the economy are classified under ten sectors viz. Food crops, Other agriculture and mining, Other basic needs, Textiles, Heavy industry, Light industry, Construction and transportation, Energy, and Services. The economic subsystem predicts the components of final demand.

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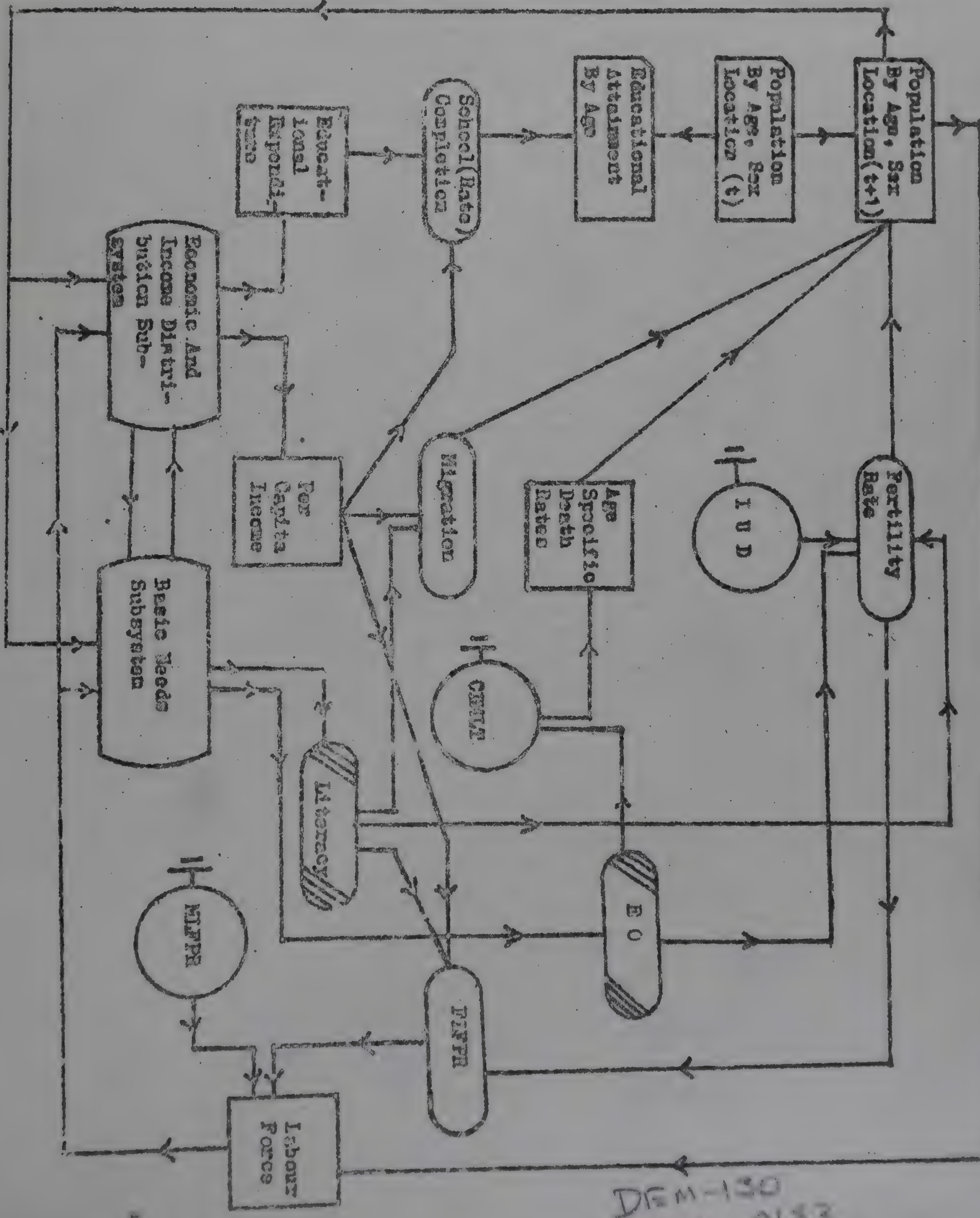
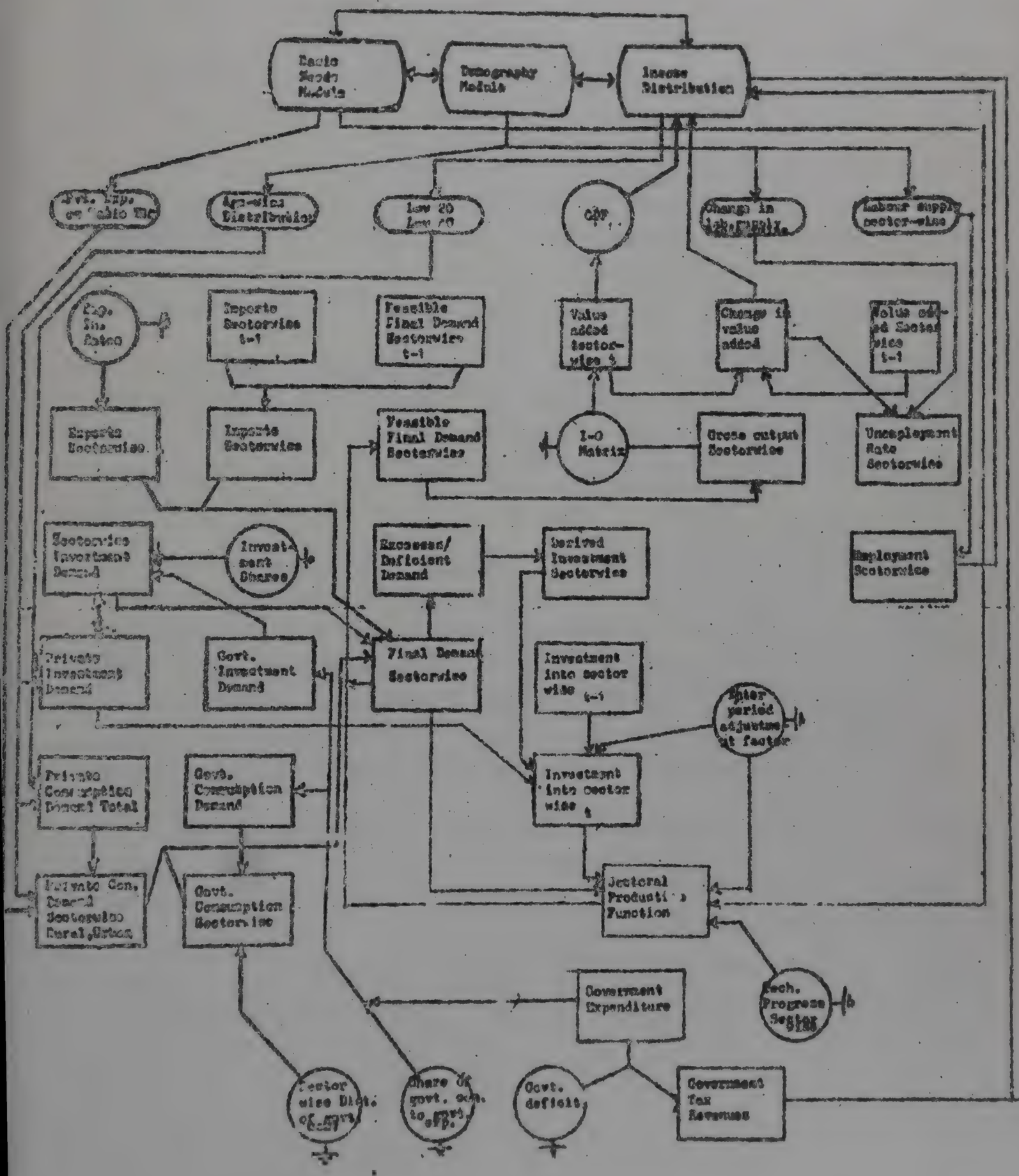




ECONOMIC SUBSYSTEM

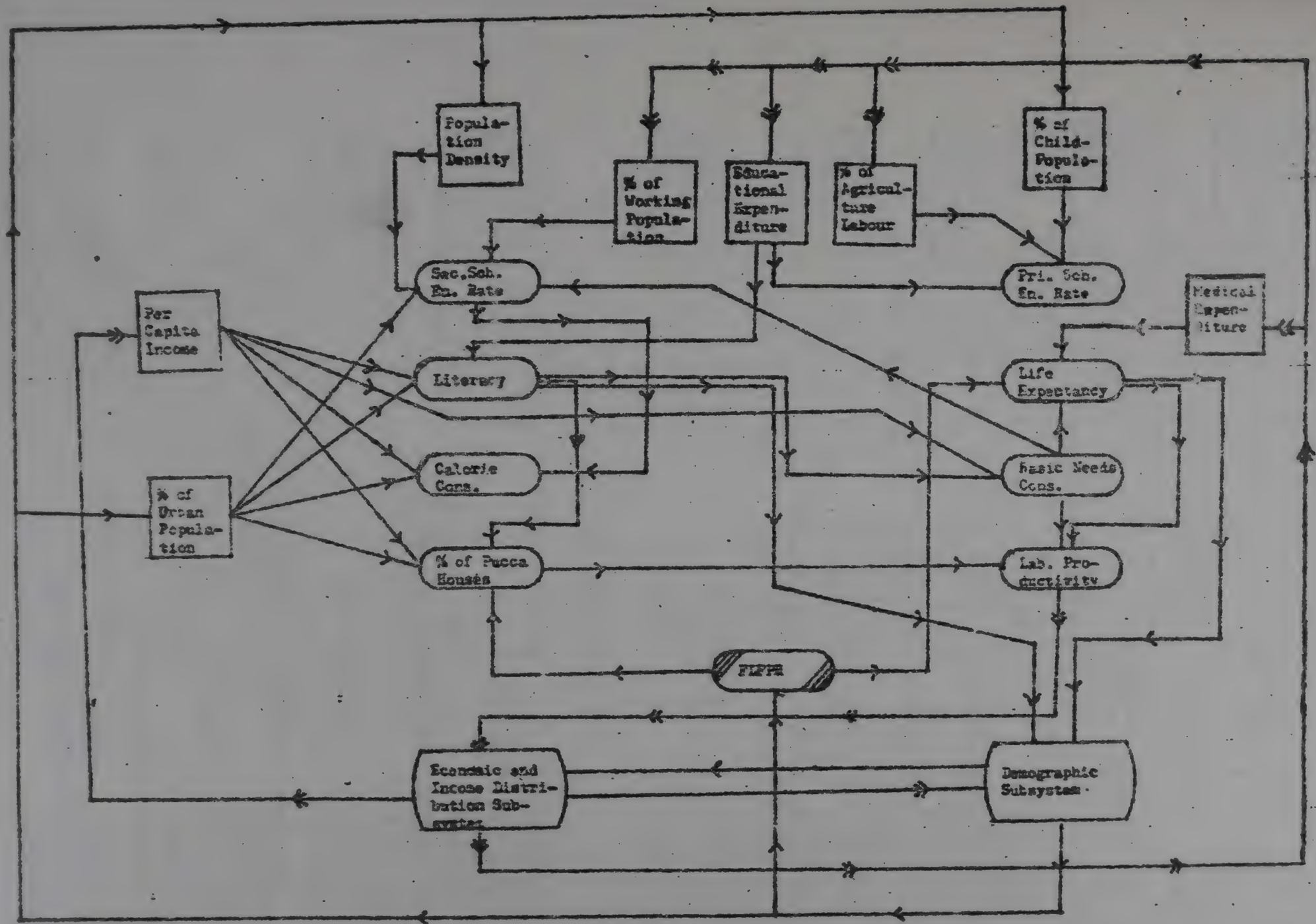
A ten sector input-output matrix corresponding to the above sectors is used for computing the total output and value added by each sector. The unemployment rates are estimated from changes in labour force and the proportions of sectoral capacity for each sector in rural/and urban areas. (An overview of the major economic interrelationships in this system is give in figure 2.3)

Sectoral value added is divided into rural and urban and these into wages and profits in the income distribution subsystem. Mean earnings and distribution of earnings for each of the categories (Rural/Urban and Employers/Employees) and for the economy are computed. The share of income going to the lowest 20 and lowest 40 percent of the population is also computed.

(4) Basic Needs Subsystem: The Basic Needs subsystem specifies some of the basic needs satisfaction of the population such as calorie consumption, health, availability of commercial energy to the household, change in labour productivity, etc. (see figure 2.4 for major interrelationships in this system).

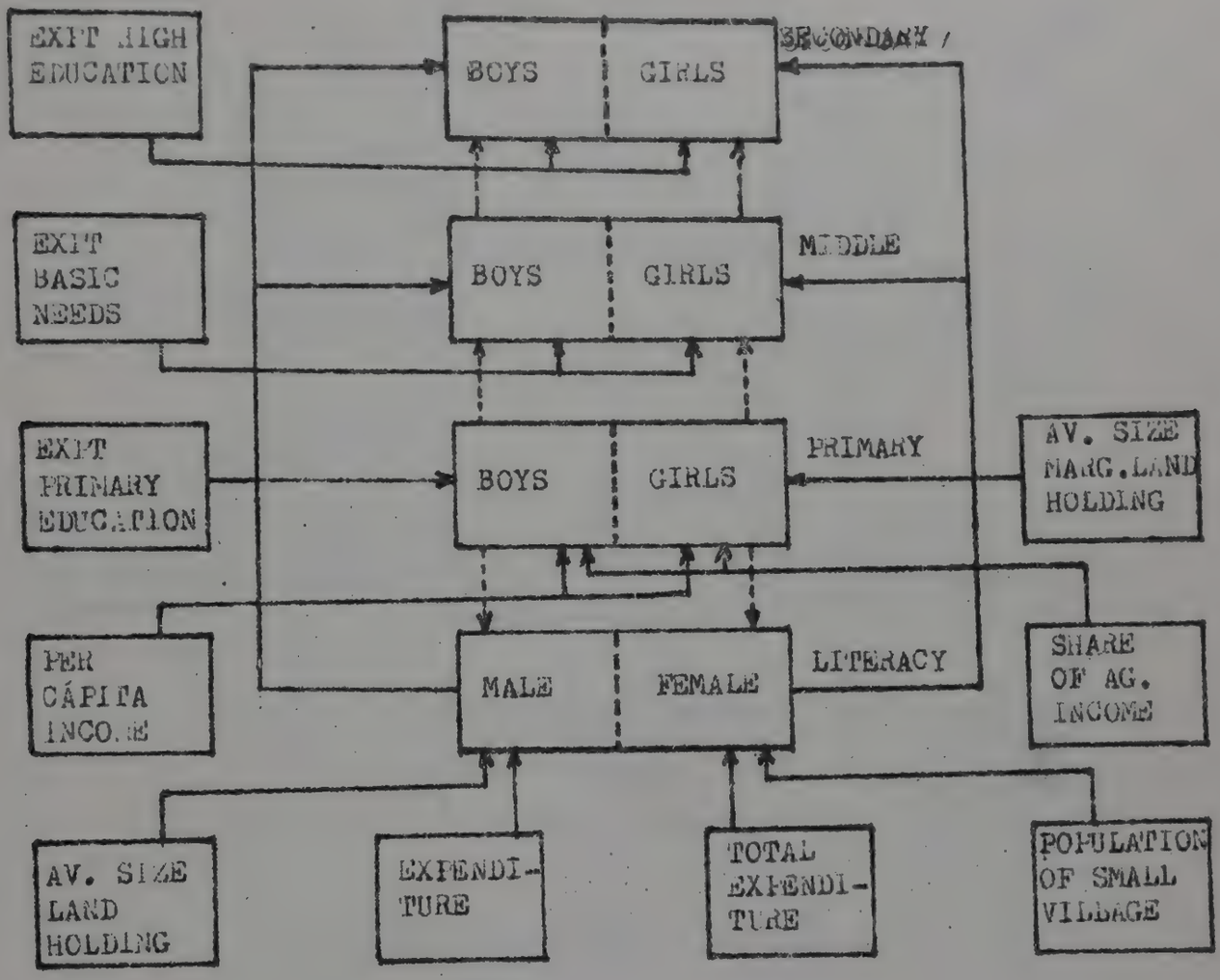
(5) The Education Subsystem: The education subsystem contains equations for male and female literacy rates in rural and urban areas. It also estimates the enrolment rates of girls and boys at the primary, middle and secondary level of education separately for rural and urban areas. A recursive system is specified for the enrolment rates at these different levels, with the proper lags. Figure 2.5 . . give an overview of the structure of the system and its linkages to other subsystems in the model.

(6) The Labour Supply Subsystem: Labour force participation rates for specific age groups in the male and female population are worked out in this subsystem separately for rural and urban areas. The following age groups are identified: 6 to 14, 15 to 19, 20 to 24, 25 to 59 and 60+. This kind of break up is quite important as the first three age group are closely linked with school enrolment rates, with changes in age at marriage etc. This subsystem is explained in figure 2.6

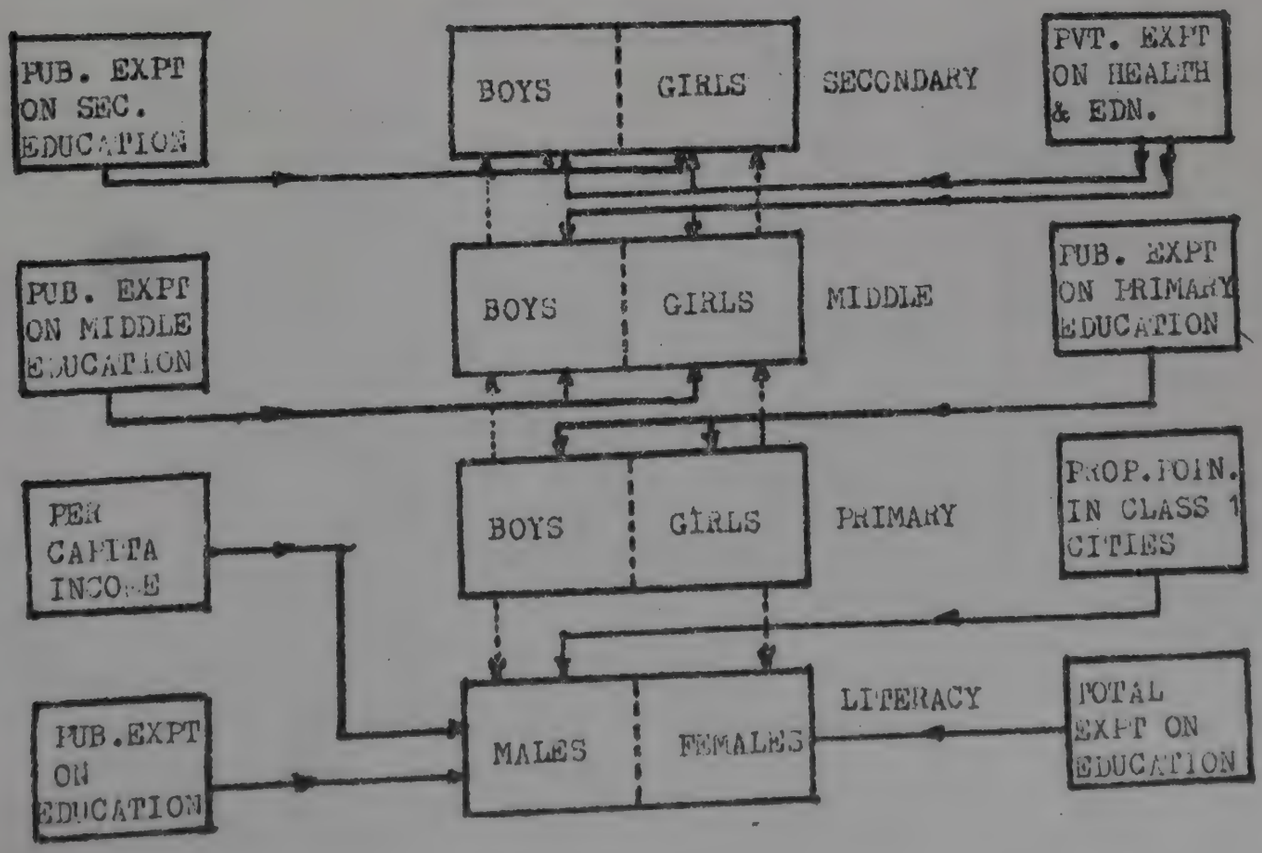


Basic Needs Subsystem.

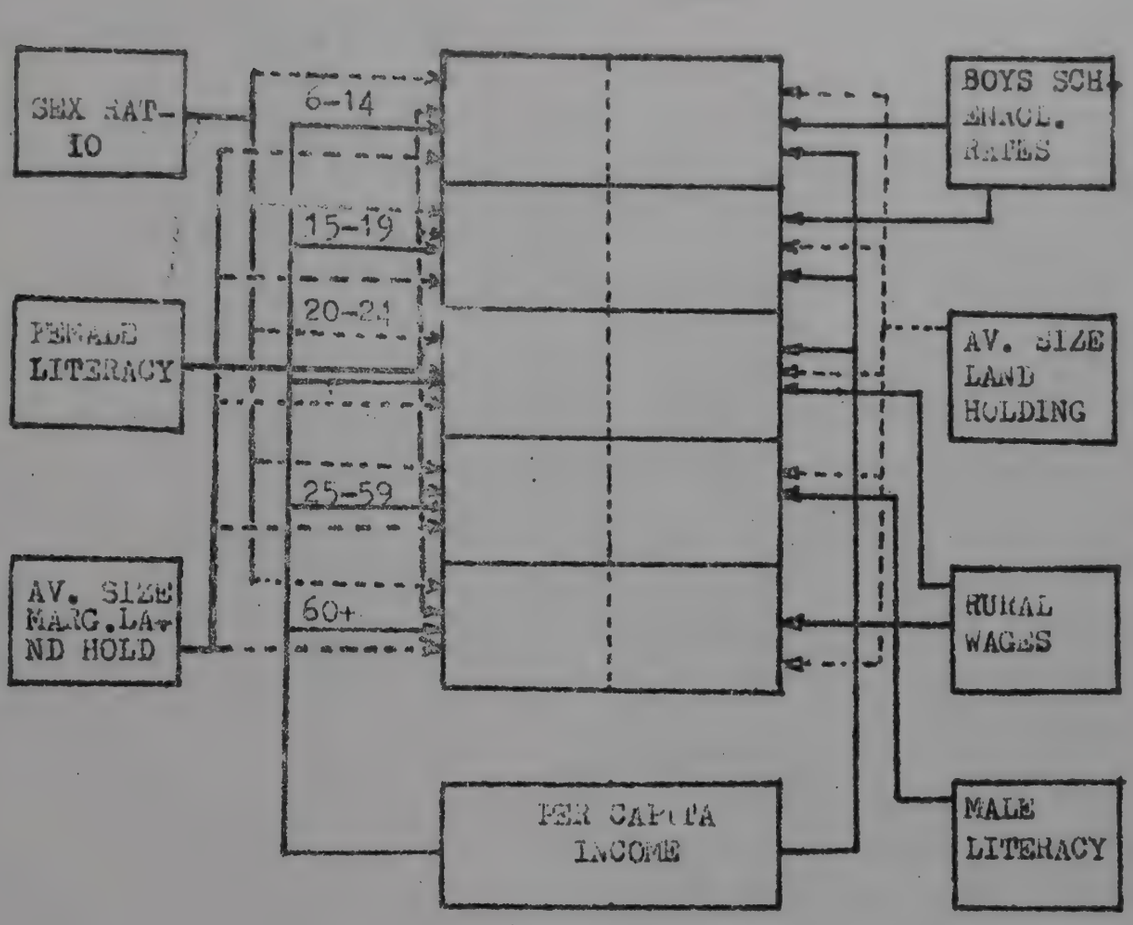
RURAL EDUCATION SUB. MODEL



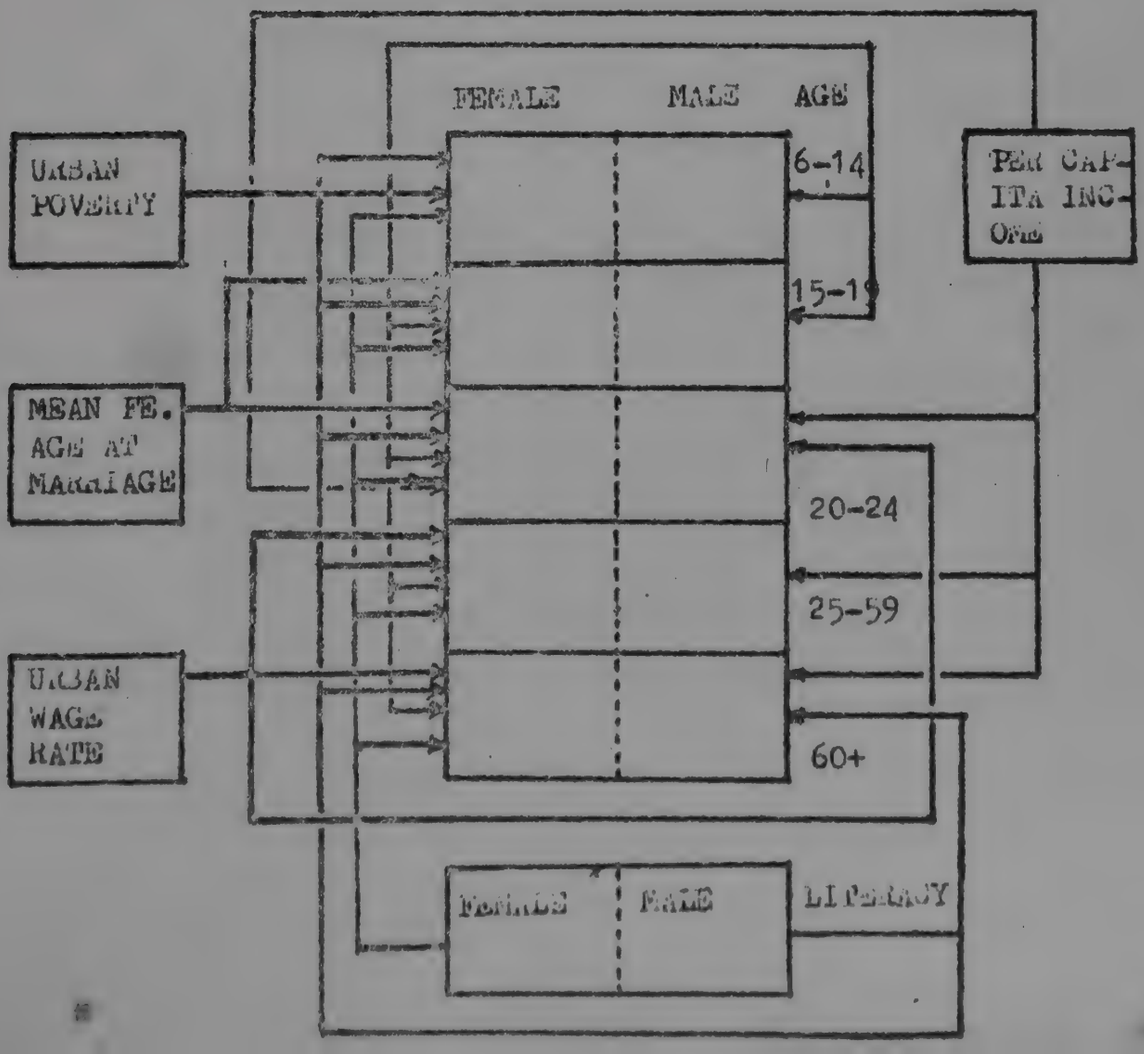
URBAN EDUCATION SUB. MODEL

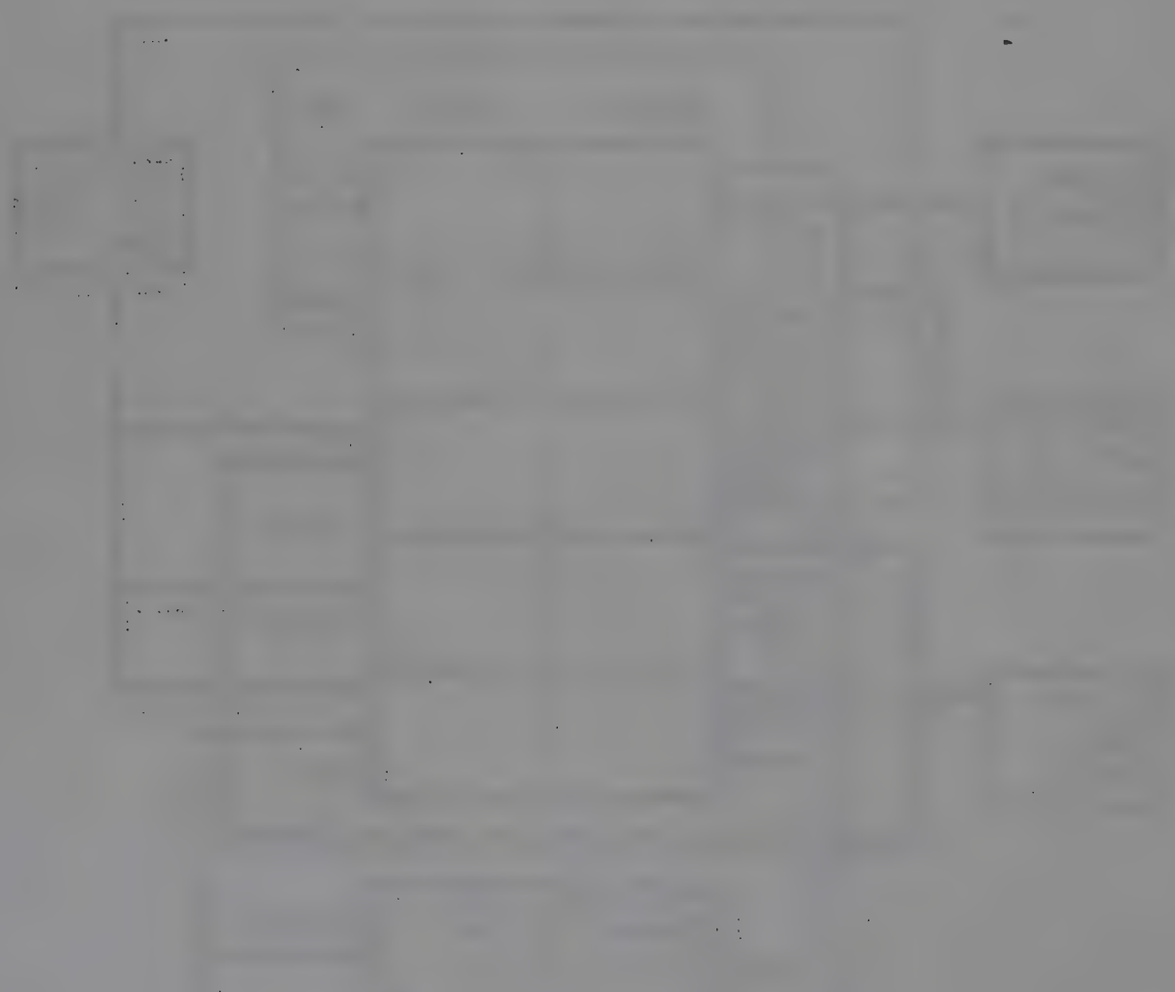


LABOUR FORCE PARTICIPATION (RURAL)



URBAN LABOUR FORCE PARTICIPATION





2.3 Applications of the Model

(a) Export strategies: The model has been applied to study the behaviour of the economy under two different export strategies with common policies of minimising imports (except, of course, energy) and more expenditure on basic needs. (For complete details see Krishnayya et al, 1981).

'Scenario one' refers to a strategy where exports to the developed world (mainly consumer goods) are increased, whereas under 'Scenario two' exports to less developed countries are increased (mainly capital goods). The simulation results suggest that the economy will progress much faster under 'Scenario one'. By the year 30 exports are about 71.5% higher compared to the normal base run while it is only 34% higher under 'Scenario two'. But the difference is not as great with per capita income: up by 43% under 'Scenario one' vs 3% under 'Scenario two'. The unemployment rate falls further under 'Scenario one' than under 'Scenario two'. Though there is slight decline in fertility rate, the population has remained more or less the same under both the scenarios due to the declining mortality rate associated with higher basic needs satisfaction. Thus it follows that a higher economic growth, per se, need not result in a reduced rate of growth of population. It is interesting to find that income inequality has slightly worsened under both the scenarios compared with the slow-growth base run, as measured by the Gini coefficient, and by the share of income going to the lowest 20 or 40 percent of the population.

(b) "Food for Work Program" (FfW) as a development strategy: The Food for Work Programe aims to utilise the country's available food stocks for insulating the economically handicapped sections of the rural community from hunger. This program offers society a chance to strengthen rural infrastructure (roads, rural housing etc.) and to create productive assets like minor irrigation works, at the cost of reducing the food surplus which must otherwise be stored at considerable expense. The India Basic Needs Model has been used to study the short and long term impact of various sizes of Food for Work Program on the rest of the socio-economic system, to answer questions such as:

1) Can such a programme make an impact on rural unemployment?
2) What about the negative effect due to removing money from government Investment and Consumption?
3) How much does the growth of economy suffer due to such diversion of resources?
4) How much will the urban sector have to suffer (in terms of employment, income etc.) for the benefit of the rural poor?
5) What are the short and long run implications if the programme is discontinued abruptly?
6) To what extent can this program be adopted as a development strategy to reduce rural poverty and what are the associated costs?

Under various meaningful assumptions a number of strategies in terms of the size and time horizon of the FfW programme have been tried.

Scenario A describes an expanding but modest FfW programme with a cost of Rs. 2950 million in 1980 and which increases to Rs. 8350 million in 2000 (an increase of Rs. 270 million annually). Under this scenario the population below poverty is reduced by 8 percent and rural unemployment has fallen by 19 percent in 2000 at a cost of .5 percent decline in overall per capita income and .6 percent increase in urban unemployment rate. (All percentage changes are with respect to Normal Base run results)

Scenario B refers to a programme of the same size as Scenario A but operating only for the 10 year period 1980-1990. It is interesting to note the long term effects of such a short term programme are all unfavourable: the rural and urban unemployment rate etc. have increased, the per capita income, per capita calorie intake, the share of poor people, etc. have decreased.

A major programme of FfW is described under Scenario C. By 2000 the size of the programme reaches to Rs. 21950 million (the programme is expanded by Rs. 950 million (almost 100cr) every year) - yet the over all per capita income falls only by one percent whereas the percentage of the population below the poverty line falls by 23.5 percent (over 125 million people have been brought above the poverty line) and the rural unemployment rate is halved A summary of the results of scenarios A & B is given in Table 1.1

	Scenario B			Scenaro C		
	1980	1990	2000	1980	1990	2000
Programme Details						
Period of operation of the programme	(1978-1990)			(1978-2000)		
Yearly cost of the programme (Rs.Mill.)	2950	2950	----	2950	12450	21950
Food required to operate (Mill.Tons)	2.0	2.0	----	2.0	8.3	14.6
Direct Employment created (Mill.Man years)	2.4	2.4	----	2.4	10.2	18.0
Rural Labour Supply (Mill. Man years)	168.5	211.3	265.4	168.5	211.6	266.5
Total indirect employment (Mill. Man years) because of FfW.	1.8	1.1	----	1.8	6.0	7.0
Selected Results - % change from the Base Run						
Percapita income (Rs)	-0.08	-0.10	-0.22	-.08	-0.30	-1.07
Population below (%) poverty line	-7.22	-4.19	1.36	-7.22	-19.22	-23.48
Income per adult (Rs) Eq, Rural	0.28	0.14	-0.25	0.28	0.83	0.48
Income per adult (Rs) Eq. Urban	-0.80	-0.46	-0.10	-0.80	-2.27	-3.35
Unemployment rate (%) Rural	-19.97	-9.89	2.95	-19.97	-46.88	-52.72
Unemployment rate (%) Urban	1.58	0.30	0.34	1.58	0.96	1.30
Rural-Urban migration propensity (per 1000)	-1.47	-1.11	0.17	-1.47	-4.54	-6.20
Government investment (Rs.Mill)	-10.61	-8.26	-0.21	-10.61	-34.67	-46.91
Government consumption (Rs.Mill)	-1.37	-1.28	-0.29	-1.37	-4.37	-6.40
Per capita calorie in-take (overall(Cals)	2.09	1.23	-0,54	2.09	5.98	6.12
Per capita calorie in-take (Low20) (Cals)	5.69	3.72	-1.27	5.69	17.73	20.72

Note: The figures under selected results in scenarios A,B & C refer to the respective percentage changes from the base run for the corresponding period.

(c) Rural-Urban Energy Demand by the Housedhold Sector and Migration: The IBN model has also been used to analyse how the pattern of household energy consumption can be affected by certain socio-economic developments such as migration.

In the current study the IBN model will be used to develop a population simulation mode of India to evaluate the medium and long term socio-economic and demographic impact of raising female age at marriage. This will be done by estimating a submodel of rural and urban fertility behaviour incorporating factors such as percentage of currently married women in different age groups, women protected by family planning methods in different age groups etc. The structure of the submodel and the estimated equations are presented in the following two chapters.

CHAPTER 3

DETERMINANTS OF AGE-AT-MARRIAGE AND OF FERTILITY

3.1 Introduction

Estimating behavioural equations for the socio-economic determinants of the average age at marriage and linking them to the IBN model to find out the demographic and other changes in the medium and long term was found to be too simplistic to have any significant policy relevance. This is due to the fact that the "mean age at marriage" can be caused to vary by a change merely in the percentage of married women in any age group (e.g. less than 14 years, 15-19; 20-24 etc). Therefore we have to make additional assumptions about the particular age group or groups in which the percentages have changed and have caused changes in the mean age at marriage. Such assumptions can easily become arbitrary and less useful from the policy point of view. Thus, it is more important to know the proportions of girls getting married in specific age groups than merely to computer the mean age at marriage. Our analysis is therefore conducted on a disaggregated basis, separately for rural and urban areas and for each age group.

We have therefore re-designed the methodology as follows:
No. of children born to rural women in any age i is given by

$$RBIRTH_i = RP_i \times RMAR_i \times (1-REFCUP_i) \times \frac{REMFR_i}{1000}$$

Where
- RP_i – no. of women in age i
- $RMAR_i$ – Proportion of currently married women in age i
- $REFCUP_i$ – net Proportion of currently married women effectively protected by family planning in age i
- $REMFR_i$ – average effective fertility rate per 1000 currently married women in age i

This is repeated for urban areas also. The total number of births is obtained by adding up the results for the respective age groups.

This requires the estimation of a system of equations instead of just two separate equations (where the mean age at marriage will be treated as an additional variable in the fertility equation). For estimation purposes we

TABLE 1 Currently Married Women in Different Age Group in Rural (%) (1971)

State	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50+	Overall
Andhra	13.6	71.4	94.2	94.9	91.1	88.3	78.3	71.5	53.3	45.7
Assam	0.3	44.2	84.2	93.4	93.1	90.8	83.3	76.0	65.9	37.2
Bihar	22.5	78.2	95.8	96.7	95.2	92.0	85.8	79.4	64.6	49.9
Gujarat	4.4	44.4	92.2	96.9	96.2	93.2	87.4	82.8	68.0	43.6
Haryana	13.8	68.5	97.0	98.9	97.6	96.3	92.1	89.2	76.5	46.3
H.P.	5.2	52.4	91.5	95.9	94.8	91.3	85.1	78.3	68.3	44.5
J&K	5.5	57.1	92.8	96.8	96.3	94.6	88.5	82.6	68.8	45.1
Karnataka	7.7	54.9	90.3	94.6	91.7	88.5	79.5	71.6	54.4	41.5
Kerala	0.5	18.4	65.0	85.9	87.1	85.3	79.3	73.6	62.6	36.2
M.P.	24.7	75.0	96.8	97.3	95.6	92.7	85.1	78.8	62.1	46.5
Maharashtra	8.7	63.5	93.6	95.9	94.4	91.3	84.4	76.4	62.8	45.0
Orissa	3.8	57.6	92.6	95.8	94.9	91.6	84.1	77.6	62.0	44.5
Punjab	1.2	24.0	79.9	97.0	97.6	96.6	92.9	90.6	81.0	42.6
Rajastan	27.3	79.1	97.8	98.3	96.3	93.9	87.4	83.4	65.3	49.6
Tamilnadu	0.6	28.0	83.7	94.2	92.3	88.5	79.4	72.0	55.7	42.9
U.P.	25.2	78.8	97.1	97.8	96.3	94.4	88.7	85.7	68.8	51.8
W.B.	6.3	59.8	89.7	89.3	90.6	87.0	77.9	69.7	53.3	39.1
India	13.5	61.0	91.4	95.3	94.1	91.2	84.2	78.3	62.6	45.7

TABLE 2 Currently Married Women in Different Age Group in Urban (%) (1971)

State	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50+	Overall
Andhra	5.0	51.7	87.1	93.9	91.5	88.5	78.3	71.5	53.3	43.1
Assam	2.7	30.4	74.4	91.1	93.0	91.0	82.7	75.1	60.1	37.7
Bihar	9.5	58.5	90.7	96.5	95.9	93.9	87.6	81.9	65.1	46.8
Gujarat	1.3	27.9	80.5	94.6	95.0	92.8	85.3	78.6	60.9	41.7
Haryana	6.8	30.1	81.1	96.6	96.8	95.5	91.0	87.3	72.3	42.7
H.P.	1.1	25.5	73.9	93.7	95.8	93.8	88.1	81.9	68.1	43.1
J&K	1.3	24.5	76.6	95.2	96.4	94.4	87.4	80.2	62.8	40.2
Karnataka	2.9	36.0	77.9	92.4	92.2	89.8	80.3	72.3	56.1	40.2
Kerala	0.4	16.8	60.2	83.5	85.8	83.9	76.8	69.0	56.1	35.4
M.P.	8.3	52.9	88.9	96.4	95.8	93.5	86.6	79.7	62.0	44.4
Maharashtra	2.3	33.5	77.7	92.7	93.4	91.5	83.8	75.9	60.2	42.6
Orissa	1.7	47.0	89.7	95.9	94.9	91.8	82.9	75.2	55.2	43.6
Punjab	0.8	17.4	71.3	95.5	97.5	95.9	91.8	87.8	75.8	42.2
Rajastan	13.9	60.8	91.7	97.1	96.4	94.8	88.1	82.9	65.8	46.6
Tamilnadu	0.4	24.5	76.4	93.1	92.7	90.1	80.1	71.3	53.9	41.4
U.P.	5.6	44.2	85.4	95.6	96.3	94.9	89.7	85.1	70.0	44.1
W.B.	1.7	27.7	72.2	89.8	92.8	91.0	83.0	75.9	60.4	40.9
India	3.7	35.9	79.7	93.5	93.9	91.8	84.1	77.0	60.6	42.4

have used the consus classification of age groups of currently married women (viz 14 or less; 15-19; 20-24; 25-29; 30-34; 35-39; 40-44; 45-49 and 50-54)

The percentage of girls getting married in the first three age groups (10 to 14; 15 to 19 and 20 to 24) mostly determines the average age at marriage. In what follows an attempt has been made to identify the probable socio-economic factors and to quantify their effects on the chanses of girls getting married in the above three age-groups.

The age-specific marital fertility behaviour show that the age below 14 and above 45 are not insignificant and cannot be excluded from the analysis. Hence throughout this study the analysis of the percentage of girls married, their chances of being protected by any of the planning methods as well as their fertility behaviour has been carried out for single year age-groups from 12 to 50, for every year. The percentage of girls (women) married in each age group i.e. the currently married women in that age group, consists of newly married as well as those married earlier. From policy point of view, this definition is preferable rather than taking the newly married women in each age group. The term currently implies women having the status of being currently married which exclude all those who can be ignored from the point of fertility behaviour even though they are married. (Such as widows, divorcees etc.)

3.2 Percentage of Currently Married Women in Rural and Urban Areas.

The percentage of currently married women in each age group shows significant variations across the states as well as between rural and urban areas within a state. (See Table 1 and 2). In general, it can be observed that the difference between rural and urban areas narrows down in states such as Kerala and Assam which have a lower percentage of women married. This is due to the faster rate of decline of percentage of women married in rural areas compared to urban.

The wide variations across the states in the overall percentages of women married is caused mostly by the differences in the percentages of girls married in the lower age groups. We note too that with the exception of Assam, the percentage of women married in urban areas is considerably lower in all the states, revealing the greater social awareness of the urbanites.

3.3 Factors Determining the Percentage of Currently Married Women (Overall).

The percentage of currently married women overall is a weighted average of the percentages in the respective age groups. As such the estimation of percentage of women married in each age group should be sufficient to compute the percentage for all age groups. However, the percentage of women married in the upper age groups (25 and above) showed a lot of heterogeneity across the states to the extent that it was difficult to obtain any statistically good fit for the observed data. This is probably due to the fact that the marriages taking place in these age-groups are basically 'residuals' while some of the women are also becoming widows and divorcees at these ages. Therefore, a reasonably good fit for the overall percentage of women married was obtained and the percentages corresponding to the upper age groups were then estimated as a function of this percentage.

Literacy rate: Literacy rate may be used as a surrogate measure of the social awareness. A literate female has a number of advantages over her illiterate counterpart. Besides having greater confidence, she has better access to information, can contribute to decisions and can take an active part in the social and cultural transformation. Therefore, an expanding educational network for women could result in a declining share of women married in the total population mainly due to rising age at marriage. Increasing female literacy will also have many other economic and social effects.

Of late, parents are also realising the economic value of education. They tend to look at expenditures on education as an investment which could increase the future productivity of their wards. Besides, some "minimum level of education" is preferable, and sometimes even necessary, for the girls to get married. However, attempts to incorporate the educational content in terms of female school enrolment rates in the equation proved to be unsuccessful due to its high correlation with literacy rates.

Per capita income: The difference in per capita income of different states did not explain any part of the variation in the percentage of women married (all age groups). Though this variable was found significantly to influence the percentage of women married in the upper age groups, this influence is not

reflected in the overall percentage, possibly due to its conflicting affects on different age groups. For example a rise in percapita income could prompt the parents either to educate their children (and hence to postpone their marriage) or to utilise theextra income (e.g. from a bumper harvest) to marry off their female children and thereby get rid of an increasing liability

Income inequality, measured in terms of the share of total income going to the lowest 40 percent of the population, was found to influence the percentage of women married overall. Further investigations showed that an improved distribution of income seems to correlate with increases in the female age at marriage.

Female Labour Force Participation Rate. The effect of female labour force participation rate (all age groups) on the percentage of women married overall was also analysed. While no appreciable effect was noticed in the rural areas it has a significant negative effect in the urban areas.

The final estimated equations for the percentage of currently married women (overall) for rural and urban areas are as follows:

$$\begin{array}{lllll} \text{RMART} = & 51.44 & - 0.1989\ \text{RFL} - 0.1653\ \text{RLOW40} & R^{-2} & = 0.3207 \\ & (9.846) & (-2.879) \qquad\quad (-.691) & F & = 9.55 \end{array}$$

$$\begin{array}{lllll} \text{UMART} = & 58.88 & - 0.1682\ \text{UFL} - 0.2555\ \text{ULOW40} & R^{-2} & = 0.4562 \\ & (12.29) & (-2.982) \qquad\quad (-1.687) & F & = 16.42 \end{array}$$

$$- 0.3876\ \text{UFPRT}$$

XMART : Overall (all ages) proportion of women married

XFL : Female literacy rate in region X

XLOW40 : Proportion of income accruing to the lowest 40 percent of the population.

XFPRT : Overall female labour force participation rate

X = R for Rural, X = U for Urban

3.4 Proportion of girls married below the age 15

Enrolment rate in school, labour force participation rates and income inequality measured in terms of share of total income going to thelowest 40 percent of the population were found to influence child marriage both in rural and urban areas. An increase in enrolment rate of girls in primary

and middle schools tends to reduce the chances of their getting married , whereas the participation of female children in the labour force appears to enhance it. A more equal distribution of income negatively influences the child marriage rate.

The influence of enrolment rates requires a little explanation. It is interesting to note that the relationship between enrolment rates in primary and in middle schools of girls and their chances of getting married is a nonlinear one. This is due to the diminishing marginal impact of the enrolment rates in lower classes on the age at marriage. The demonstration effect in such matters should not also be under estimated. For example,the fact that some school-going girls generally get married later has an influence, at least socially, by enabling other parents to find an excuse to delay the marriage of their own female children. The nonlinear specifications give slightly better fit with respect to primary and middle shcool enrolment rates as follows.

		Independent Variables			
Dependent Variable	CONST.	RPG	$\frac{1}{RPG}$	RMG	$\frac{1}{RMG}$
$RMAR_{10-14}$	24.22 (5.363)	-0.3598 (-3.402)			
"	-1.681 (-.533)		369.0 (4.303)		
"	16.84 (5.437)			0.422 (-2.775)	
"	-1.408 (-.484)				124.3 (4.239)
	CONST.	UPG	$\frac{1}{UPG}$	UMG	$\frac{1}{UMG}$
$UMAR_{10-14}$	21.55 (4.857)	-0.2442 (-4.034)			
"	14.89 (4.642)		1328 (4.642)		
"	13.52 (5.064)			0.2322 (-3.750)	
"	-6.262 (2.533)				391.9 (4.239)

The participation of girls of this age group in the labour force may be considered as an indicator of the lower economic and social status of their parents. Girls are considered to be an economicliability especially among the (landless) lower strata of the rural society. Their earning capacity is too low even for their own maintenance. Thus, it is but natural that parents try their best to marry off their female children as early as possible. The estimated equations are as follows:

$$\underset{}{RMAR_{10-14}} = \underset{(0.291)}{3.247} + \underset{(1.076)}{167.0}\left(\frac{1}{RPG}\right) + \underset{(1.482)}{75.27}\left(\frac{1}{RMG}\right) + \underset{(0.289)}{0.2267}\ RFPR_{10-14} - \underset{(0.574)}{0.2838}\ RLOW40 \qquad R^{-2} = 0.5132,\ F = 20.57$$

$$\underset{}{UMAR_{10-14}} = \underset{(-1.270)}{-11.14} + \underset{(2.056)}{1018}\left(\frac{1}{UPG}\right) + \underset{(1.190)}{155.2}\left(\frac{1}{UMG}\right) + \underset{(0.334)}{0.5857}\ UFPR_{10-14} - \underset{(-.852)}{0.1618}\ ULOW40 \qquad R^{-2} = 0.5994,\ F = 27.94$$

$XMAR_a$: Proportion of rural women married in age group "a"

XPG : Enrolment rate of Girls in Primary School

XMG : Enrolment rate of Girls in Middle School

XSG : Enrolment rate of Girls in Secondary School

$XFPR_a$: Female participation rate in the labour force in age group "a"

XLOW40: Proportion of total income going to the lowest 40 percent

X = R for Rural; X = U for Urban

3.5 Proportion of girls married in the age group 15 - 19

The enrolment rate of girls in the middle and higher secondary classes were found to be important determinants of girls being married in this age group. The middle and secondary school enrolment rateshave a linear influence on the age at marriage probably due to the low present level of enrolment rates as can be seen below:

Dependent Variable	CONST.	Independent variables XMG	$\frac{1}{XMG}$	XSG	$\frac{1}{XSG}$
$RMAR_{15-19}$	75.11 (15.99)	-1.176 (-5.119)			
"	33.60 (5.376)		244.4 (4.229)		
"	76.75 (19.64)			-4.970 (-6.683)	
"	35.69 (7.584)				46.09 (5.419)
$UMAR_{15-19}$	75.33 (8.807)	-0.9537 (-4.780			
"	-4.183 (-0.512		-1551 (5.077)		
"	56.77 (11.14)			-1.935 (-4.582)	
"	2.358 (5.767)				92.16 (3.794)

Other factor which influencesthe likelihood of girls being married in this age group is the participation of girls in the labour force. The distribution of income in rural areas does not appear to have any influence on the chances of the girls being married either in this age group or the subsequent ones. However, the distribution of income has a significant negative influence in urban areas. The finally estimated equations are as follows:

$$RMAR_{15-19} = \underset{(6.770)}{62.78} + \underset{(0.986)}{57.49}\left(\frac{1}{RMG}\right) \underset{(-4.297)}{-4.361}\ RSG + \underset{(1.853)}{0.3533}\ RFPR_{15-19} \qquad R^{-2} = 0.771,\ F = 58.79$$

$$UMAR_{15-19} = \underset{(1.493)}{47.66} + \underset{(1.407)}{789.3}\left(\frac{1}{UMG}\right) \underset{(-1.456)}{-1.040}\ USG + \underset{(0.232)}{0.2239}\ UFPR_{15-19} \qquad -\underset{(1.310)}{0.9316}\ R^{-2} = 0.6500,\ F = 33.72$$

3.6 Proportion of girls married in the age group 20 - 24

Due to physical, cultural, social and economic factors the vast majority of girls are married in this age group. Yet, the percentage of married women in this age group shows considerable variation across the states in rural and urban areas. Lagged values of enrolment rates in secondary schools along with the participation rates of women in this age group in the labour force explained the above variation to some extent. The final estimated equations are as follows:

$$RMAR_{20-24} = \underset{(48.83)}{96.70} - \underset{(-7.196)}{2.227}\ RSG + \underset{(1.780)}{0.1432}\ RFPR_{20-24} \qquad R^{-2} = 0.7572,\ F = 52.03$$

$$UMAR_{20-24} = \underset{(7.341)}{122.7} + \underset{(1.504)}{22.88}\ \frac{1}{USG} \underset{(-3.215)}{-53.79}\ (UFL/UMR) \qquad R^{-2} = 0.6719,\ F = 26.62$$

The relative female literacy level appears to be a significant factor that determines the percentage of women married in this age group. This might reflect the liberal attitude of educated mothers to the personality development of their daughters.

3.7 Percentage of women married in the age groups above 25.

As explained earlier the percentage of women married in the upper age groups showed stable relationships with the percentage corresponding to "all ages". Percapita income was also found to be a significant explanatory variable.

INX = Percapita income in region

$$RMAR_{25-29} = \underset{(13.37)}{73.48} + \underset{(5.789)}{0.6377}\ RMART - \underset{(2.153)}{3621}\ \frac{1}{INR} \qquad R^{-2} = 0.6812,\ F = 36.19$$

$$RMAR_{30-34} = \underset{(15.36)}{81.54} + \underset{(4.474)}{0.4761}\ RMART - \underset{(-2.924)}{4751}\ \frac{1}{INR} \qquad R^{-2} = 0.6537,\ F = 0.6402$$

$$RMAR_{35-39} = \underset{(14.29)}{81.64} + \underset{(4.299)}{0.4926}\ RMART - \underset{(3.827)}{6695}\ \frac{1}{INR} \qquad R^{-2} = 0.6395,\ F = 13.15$$

$$RMAR_{40-44} = \underset{(9.282)}{77.26} + \underset{(3.675)}{0.6133}\ RMART - \underset{(-4.371)}{11140}\ \frac{1}{INR} \qquad R^{-2} = 0.6814,\ F = 29.94$$

$RMAR_{45-49}$ = 68.43 + 0.8189 RMART − 14600 $\frac{1}{INR}$ R^{-2} = 0.6094
(5.905) (3.525) (−4.117) F + 29.96

$RMAR_{50+}$ = 78.73 + 0.5723 RMART − 21670 $\frac{1}{INR}$ R^{-2} = 0.6124
(5.573) (1.915) (−5.013) F = 27.28

$UMAR_{25-29}$ = 52.49 + 0.9786 UMART R^{-2} = 0.6789
(7.494) (5.902) F = 34.82

$UMAR_{30-34}$ = 69.31 + 0.6924 UMART −3305 $\frac{1}{INU}$ R^{-2} = 0.4606
(7.895) (3.799) (−1.024) F = 15.66

$UMAR_{35-39}$ = 68.09 + 0.6969 UMART − 4116 $\frac{1}{INU}$ R^{-2} = 0.4107
(6.903) (3.419) (−1.140) F = 13.15

$UMAR_{40-44}$ = 58.89 + 0.8459 UMART − 7511 $\frac{1}{INU}$ R^{-2} = 0.2898
(3.725) (2.589) (−1.298) F = 8.53

$UMAR_{45-49}$ = 43.93 + 1.095 UMART − 9147 $\frac{1}{INU}$ R^{-2} = 0.2845
(2.152) (2.594) (1.224) F = 8.36

$UMAR_{50+}$ = 47.85 + 0.8033 UMART − 15160 $\frac{1}{INU}$ R^{-2} = 0.1615
(1.879) (1.526) (−1.627) F = 5.08

The estimated equations reveal a very interesting pattern. The statistical significance of percapita income increases from lower to higher age groups noticably in the rural areas. In general, these equations give a good fit except for urban women married in the age groups above 40

3.8 Single-age specific currently married women.

The age specific percentage of currently married women was computed by fitting a linear trend between the mid points for the successive age groups for rural and urban. Further they were smoothed by calculating the five year moving average. The percentage of currently married women in each age thus obtained, is show in graph 3.1

3.9 Determinants of Effective Marital Fertility Rate.

Effective marital fertility rate is defined as the number of live births per 1000 currently married and unprotected women. Census data provides the

marital fertility rate (i.e. number of live births per 1000 currently married women). The age-wise distribution of protected women was used to calculate the effective marital fertility rate from the marital fertility rate (In the absence of more detailed data, the same age distribution for protected women was assumed for rural and urban areas.)

A combination of interdependent biological and of direct and indirect socio-economic and demographical factors jointly determine the effective marital fertility rate. A systematic study of the fertility behaviour necessitates the specification and estimation of a simultaneous equations system which explicitly incorporates the interdependent behaviour of the system. However, this is not attempted in the present study as it would require separate and lengthy research.

It should be noted that variations in the effective marital fertility rate are not entirely due to biological differences: For, the fertility behaviour of unprotected married women is also affected by a number socio-economic and cultural factors such as - literacy rates, labour force participation rate, percentage of women married to total female population, life expectancy, housing characteristics, share of agricultural labour in total labour force, indicators of asset distribution, income inequality per capita income, level of poverty, average earning.

All of these variables were tested using state-wise data collected by us to explain the variations in the effective marital fertility rates across the states in rural and urban areas. Due to the problem of multicollinearity, some of thevariables had to be dropped and the estimated equations are as given below:

$$\underset{}{REMFRT} = \underset{(5.350)}{312.5} \underset{(-1.22)}{- 1.291}\ RFL \underset{(-1.837)}{- 0.9383}\ RFPRT \quad R^{-2} = 0.5359,\ F = 15.01$$

$$\underset{(1.998)}{-2.431}\ RMART$$

$$UEMFRT = 174.5 \underset{(-3.050)}{- 0.4923}\ UFL \underset{(-1.394)}{- 0.8172}\ UFPRT \quad R^{-2} = 0.5310,\ F = 15.22$$

XEMFRT = Effectove marital fertility rate

XFPRT = Female labour force participation rate

The Female literacy rate, both in rural and urban areas, was found to be highly significant, with a negative coefficient. Literacy can be considered to be a surrogate measure of manyof the social and cultural factors which tend to limit the family size. In the absence of data on the labour force participation rate of all unprotected currently married women, the available data relating to "all families" was used to test the effect of the "opportunity cost" of having a child on their fertility behaviour. The estimated coefficient is statistically significant and negative for urban, implying that working women prefer not to have more children at the cost of reduced income and job security.

For specification purposes the percentage of currently married women (all ages) was also included as an explanatory variable in the equation for rural areas. A high percentage of girls already married in the lowest age group considerably reduces the (overall) effective marital fertility rate due to a higher percentage of infecund women. As expected, this variable is statistically significant with a negative sign. Thus, in general, a lower percentage of currently married women implies rising age at marriage, thereby reducing the share of infecund women and leading to a higher fertility rate (but not, of course, necessarily to a higher number of births). This variable did not appear to be statistically significant in the equation for urban women due to the low percentage of girls married in the lowest age group.

It should be noted that an increase in the age at marriage, though it increases both the marital and the effective marital fertility rates, in fact leads to a decline in the gross fertility rate due to a reduction in the percentage of women married in the total population .

3.10 Age-specific Effective Marital Fertility Rate

Nonavailability of data is the major constraint in estimating equations to project age-specific marital fertility rates for single ages or specific age groups at the macro level. Census data provides only the marital fertility rates for specific age groups but not the corresponding socio-economic characteristics. Thus we were constrained to estimate the over-all age-specific effective marital fertility behaviour in rural and urban areas.

The marital fertility rates were suitably deflated by the age specific distribution of protected women to obtain the effective marital fertility rates in rural and urban areas. The age specific effective marital fertility rate was obtained by fitting a polynomial to effective marital fertility rates in various age groups in rural and urban areas. The actual observations and the estimated functions are given in graph 3.[illegible].

The estimated functions are given below:

$$\underset{i}{REMFR} = \underset{(28.03)}{8967.8} - \underset{(-25.40)}{217.2}\ AGE_i + \underset{(21.52)}{1.723}\ (AGE)_i^2 - \underset{(-27.27)}{132299}\ (AGE_i)^{-1} + 635862\ (AGE_i)^{-2}$$

$R^{-2} = 0.9989$
$F = 6398$

$$\underset{i}{UEMFR} = \underset{(11.82)}{4250.5} - \underset{(-10.37)}{147.74}\ AGE_i + \underset{(8.91)}{1.391}\ (AGE_i)^2 - \underset{(-11.11)}{966236}\ (AGE_i)^{-2} + \underset{(10.36)}{6920430}\ (AGE_i)^{-3}$$

$R^{-2} = 0.9944$
$F = 711.4$

The shape of the age specific (general) fertility rates can, of course, change drastically due to changes in the agewise distribution of married women or of women protected. However, the shape of the age specific effective marital fertility curve will be more stable in the short run, but will tend to change in the long run. The changes will be in the direction of increasing the rates in the lower age groups (due to higher share of fecund women in this group) and a fall in the rates in higher age groups (due to biological reasons such as higher risk to the life of mother and child and socio-economic factors such as social stigma and cost of bringing up an additional child etc.). This is further supported by the shapes of the curves for rural and urban in the above graph. Thus, one would expect the shape of the rural fertility curve to approach that of the urban.

In the present study single-age effective marital fertility rate was obtained by proportionately changing them for any changes in the overall effective marital fertility level. The shape of curves (plotted between age-specific marital fertility rates and percentage of women married in that age) drawn for

different states did not appear to indicate any definite pattern with varying levels of over-all marital fertility rates. This is clearly an area which requires greater in-depth analysis by collecting primary data.

3.11 A Note on the Estimation of Percentage of Currently Married Women

1. The dependent variable consisted of total women married rather than women got married in that age group which might have been more appropriate. This was done as the explanatory variables related to the total women in that age group. The problem of getting a lower percentage of married women in a higher age group than that of the lower will not arise in the first three age groups due to the nature of the explanatory variables. (For example a higher enrolment rates in middle school required still higher enrolment rate in the primary or a reduction in the drop-outs. The constants in such equations, if they are linear, could also reflect the percentage of girls who got married in the preceding age group.

2. Since there was a one to one correspondence between the two age groups related to enrolment and marriage, appropriate lagged values of these enrolment rates were to be used for the estimation. However, due to lack of year-wise data this could not be done.

3. In a dynamic simulation model the nature of the estimated function and the valid ranges of the variables in the function are extremely important. In other words the nature and shape of the function (there may even be a discontinuity) could change with a larger range of the variable. This aspect has been kept in mind while doing the policy simulations.

4. Except for the age-specific fertility equations, all the others were were estimated using cross section data related to the major 17 states in India. The period of reference is generally 1971. The statistical significance of the estimated coefficients can be compared using the following table.

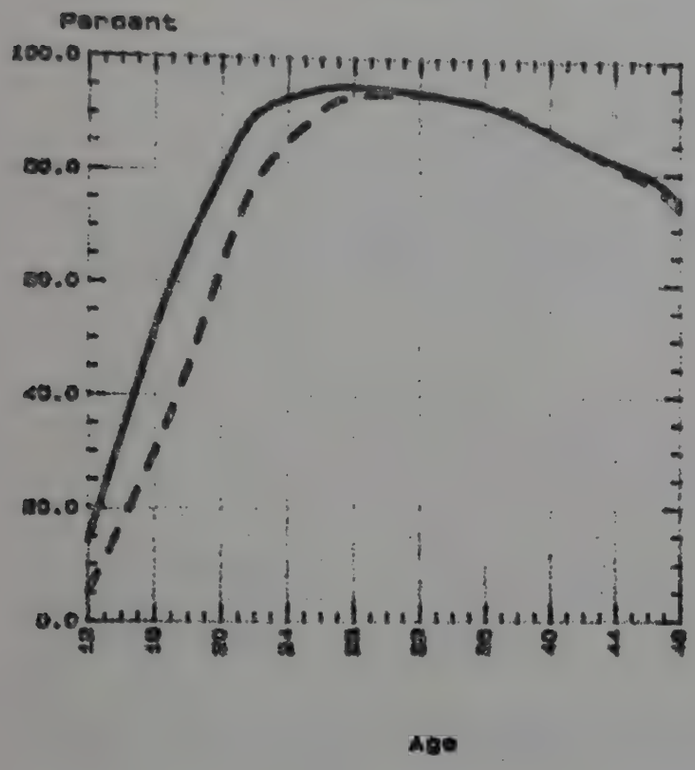
Table 't' Values

d.f.	Level of Significance		
	.10	.05	.01
12	1.782	2.179	3.005
13	1.771	2.160	3.012
14	1.761	2.145	2.977
15	1.753	2.131	2.947

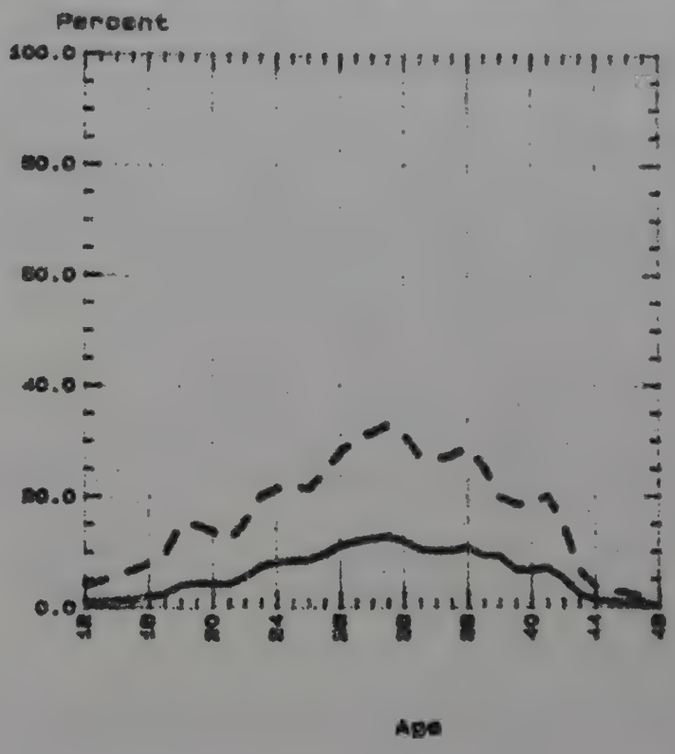
The 't' Values correspondence to each of the estimated coefficient is given underneath in brackets. This value can be compared with the above table values corresponding to appropriate degrees of freedom to determine the level of statistical significance of the estimated coefficient

GRAPH SHEET 3.1

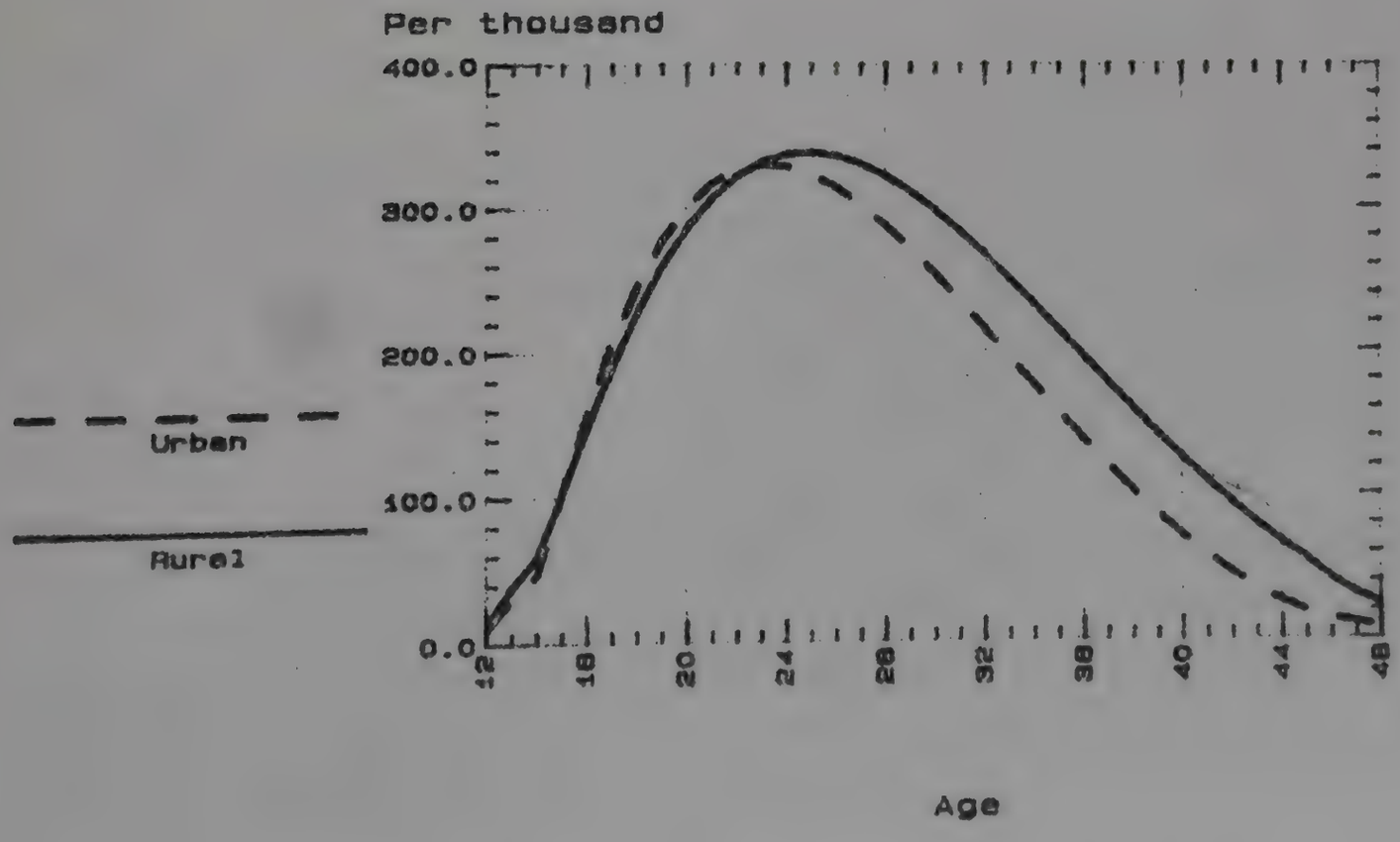
Percentage of Married Women
(1871)



Percentage of Married Women
Protected by F. P. Methods (1871)



Effective Marital Fertility Rate
(1871)

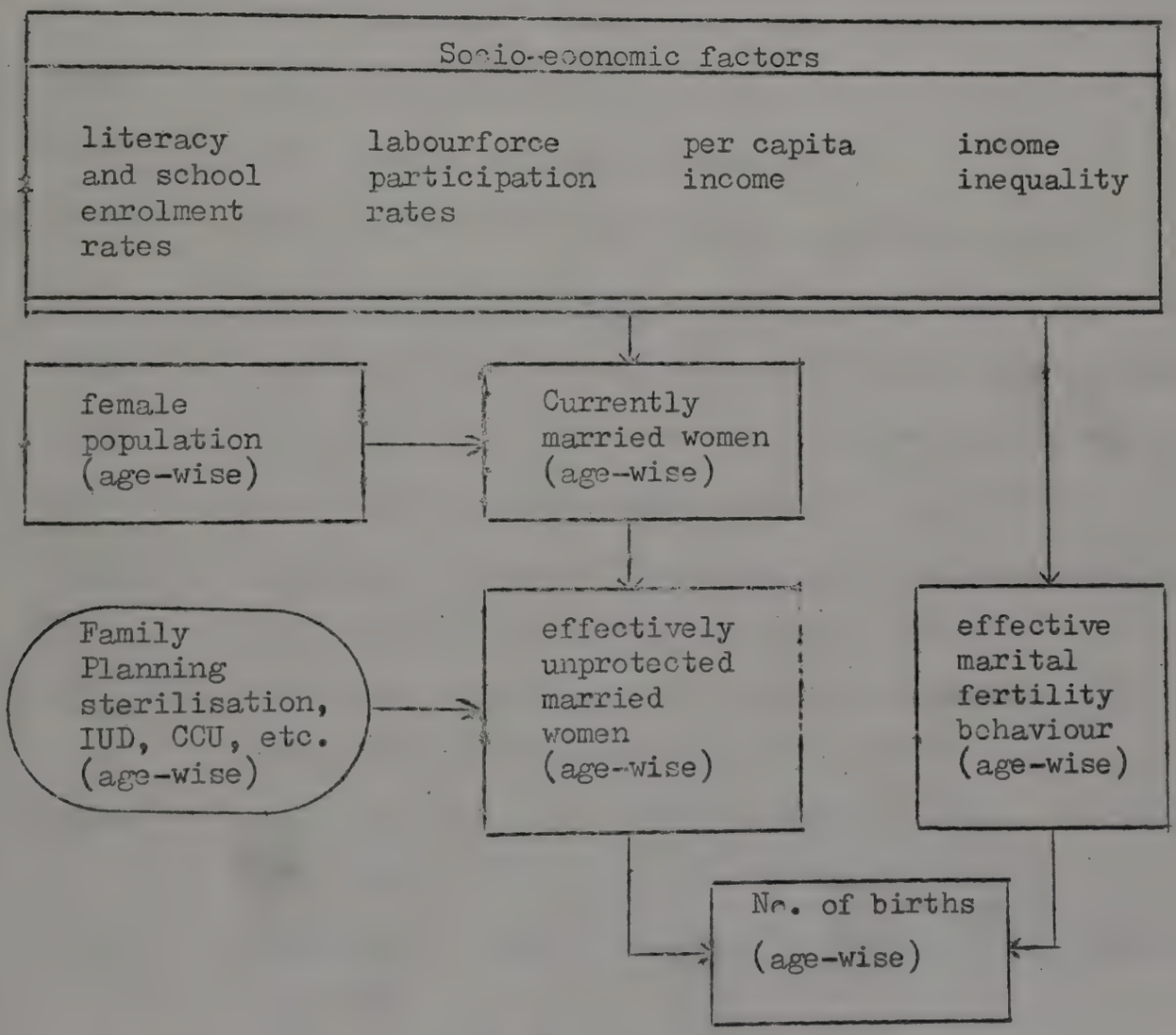


CHAPTER 4

A SUBMODEL OF AGE AT MARRIAGE AND FERTILITY BEHAVIOUR IN RURAL AND URBAN AREAS

4.1 Introduction:

As mentioned in chapter 2, in the effort to link female age at marriage to number of births, one has to take into account explicitly a number of intermediate factors. A simple flow chart to represent the broad linkages is:



Except for the family planning variables (level of different methods, their agewise distribution etc.) all other variables in this submodel are endogenised into the main model. Though it is feasible to endogenise the FP variables too, this has not been attempted here as the available data at the state and national level are inadequate.

4.2 List of variables:

$RBIRTH_i$: No. of children born to married women aged i in rural areas

RCBR : Rural crude birth rate

RFR : Rural fertility rate defined as number of live births per 1000 female population

$RMFR_i$: Rural marital fertility rate defined as number of live births per 1000 female population in age i in rural

$REMFR_i$: Rural effective marital fertility rate defined as number of live births per 1000 currently married women in age i in rural

RPOP : Total rural population

$RFPOP_i$: Rural female population in age i

$RMFPOP_i$: Currently married rural female population in age i in rural

$RMAR_i$: Percentage of currently married women in age i in rural

$RSTERT^t$: Total number of sterilisation performed during the year t

$RIUDT^t$: Total number of IUD insertions performed during the year t

$RCCUT^t$: No. of contraceptive users during the year t

$RPSTER_i^t$: Percentage of married women protected by sterilisations in age i to total sterilisations during the year t

$RPIUD_i^t$: Percentage of married women protected in age i by IUD to total women protected by IUD during year t

$RPCCU_i^t$: Percentage of married women protected in age i by CCU to total women protected by CCU during the year t

$RSTER_i$: Percentage of women protected by sterilisation in age i in rural

$RESTER_i$: Percentage of women effectively protected by sterilisations in age i in rural (= ERS x $RSTER_i$)

$RIUD_i$: Percentage of women protected by IUD in age i in rural

$REIUD_i$: Percentage of women effectively protected by IUD in age i in rural (= ERI x $RIUD_i$)

$RCCU_i$: Percentage of women protected by contraceptive uses, including pills, in age i in rural

$RECCU_i$: Percentage of women effectively protected by contraceptive use including pills in age i in rural = (ERC x $RCCU_i$)

$REFCUP_i$: Percentage of women effectively protected by all FP methods to total currently married women age i in rural

$RFCUP_i$: Percentage of women protected by all family planning methods in age i in rural

ERS : Effective rate of protection due to sterilisation

ERI : Effective rate of protection due to IUD

ERC : Effective rate of protection due to contraceptive

DR_i : Percentage of drop-out of IUD acceptors

INR : Rural per capita income

INU : Urban per capita income

RLOW40 : Percentage of total income going to the lowest 40 percent of the population in rural

ULOW40 : Percentage of total income going to the lowest 40 percent of the population in urban

RPG : Primary school enrolment rate of girls in rural

RMG : Middle school enrolment rate of girls in rural

RSG : Secondary school enrolment rate of girls in rural

UPG : Primary school enrolment rate of girls in urban

UMG : Middle school enrolment rate of girls in urban

USG : Secondary school enrolment rate of girls in urban

RFL : Female literacy rate in rural

UFL : Female literacy rate in urban

$RFPR_i$: Female labour force participation rate in age i in rural

$RSRF_i$: Survival rate of females in age ^{i}/in rural

a_i : Average annual growth of percentage of women protected in age i by sterilisation to total women protected by sterilisation during year t

b_i : Average annual growth of percentage of women protected in age i by IUD to total women protected by IUD during year t

c_i : Average annual growth of percentage of women protected in age i by CCU to total women protected by CCU during year t

T : Number of years from 1971

Note : The variable name for Urban areas uses a "U" instead of an "R"

4.3 The MF Model:

$$RBIRTH = \frac{RCBR}{1000} \times RPOP$$

$$= \frac{RFR}{1000} \times RFPOP$$

$$= \frac{RMFR}{1000} \times RMFPOP$$

$$= \sum_{i=12}^{50} \frac{RMFR}{1000}_i \times RMFPOP_i$$

$$= \sum_{i=12}^{50} \frac{RMFR}{1000}_i \times \frac{RMAR}{100}_i \times RFPOP_i$$

$$= \sum_{i=12}^{50} \frac{RFMFR}{1000}_i \times \frac{RMAR}{100}_i \times \left(1 - \frac{REFCUP}{100}_i\right) \times RFPOP_i$$

$$RBIRTH_i^t = \frac{REMFR}{1000}_i^t \times \frac{RMAR}{100}_i^t \times \left(1 - \frac{REFCUP}{100}_i^t\right) \times RFPOP_i^t$$

$$REFCUP_i^t = \left[RESTER_i^t + REIUD_i^t + RECCU_i^t \right] \times 100 / RFPOP_i^t$$

$$RESTER_i^t = RSTER_{i-1}^{t-1} \times RSRF_{i-1}^{t-1} + \left(RSTERT^t \times \frac{RPSTER}{100}_i^t\right)$$

$$RIUD_i^t = RIUD_{i-1}^{t-1} \times RSRF_{i-1}^{t-1} \times (1-DR_i) + \left(RIUD^t \times \frac{RPIUD}{100}_i^t\right)$$

$$RCCU_i^t = RCCUT^t \times \frac{RPCCU}{100}_i^t$$

$$RPSTER_i^t = RPSTER_i^{1971} + a_i T \quad \text{for } i = 12 \text{ to } 50 \text{ such that}$$

$$\sum_{i=12}^{50} RPSTER_i^t = 100.0$$

$$RPIUD_i^t = RPIUD_i^{1971} + b_i T \quad \text{for } i = 12 \text{ to } 50 \text{ such that}$$

$$\sum_{i=12}^{50} RPIUD_i^t = 100.0$$

$$RPCCU_i^t = RPCCU_i^{1971} + c_i T \quad \text{for } i = 12 \text{ to } 50 \text{ such that}$$

$$\sum_{i=12}^{50} RPCCU_i^t = 100.0$$

$$RESTER_i^t = ERS \times RSTER_i^t$$

$$REIUD_i^t = ERI \times RIUD_i^t$$

$$RECCU_i^t = ERC \times RCCU_i^t$$

$$RMART = 51.44 - 0.1989\ RFL - 0.1653\ RLOW40$$

$$RMAR_i = 3.247 + 167.0 \frac{1}{RPG} + 75.29 \frac{1}{RMG} + 0.2267\ RFPR_i - 0.2838\ RLOW40 \quad \text{for } i = 10 \text{ to } 14$$

$$RMAR_i = 62.78 + 57.49 \frac{1}{RMG} - 4.361\ RSG + 0.3533\ RFPR_i \quad \text{for } i = 15 \text{ to } 19$$

$$RMAR_i = 96.70 - 2.227\ RSG + 0.1432\ RFPR \quad \text{for } i = 20 \text{ to } 24$$

$$RMAR_i = 73.48 + 0.6377\ RMART - 3621 \frac{1}{INR} \quad \text{for } i = 25 \text{ to } 29$$

$$RMAR_i = 81.54 + 0.4761\ RMART - 4751 \frac{1}{INR} \quad \text{for } i = 30 \text{ to } 34$$

$$RMAR_i = 81.64 + 0.4926\ RMART - 6695 \frac{1}{INR} \quad \text{for } i = 35 \text{ to } 39$$

$$RMAR_i = 77.26 + 0.6133\ RMART - 11140 \frac{1}{INR} \quad \text{for } i = 40 \text{ to } 44$$

$$RMAR_i = 78.73 + 0.5723\ RMART - 21670 \frac{1}{INR} \quad \text{for } i = 45 \text{ to } 50$$

$$REMFRT = 312.5 - 1.291\ RFL - 0.9383\ RFPR - 2.431\ RMART$$

$$REMFR_i^t = \left[8967.8 - 217.2\ (i) + 1.723\ (i)^2 - 132299\ (i)^{-1} + 635862\ (i)^{-2} \right] x \frac{REMFRT^{t-1}}{REMFRT^t}$$

The effective rate for protection for sterilisation, IUD and contraceptive use were taken as 100 percent, 95 percent and 50 percent respectively.

The structure of submodel for the urban is same as that of the rural. The behavioural equations are:

$$UMART = 58.88 - 0.1682\ UFL - 0.2555\ ULOW40 - 0.3876\ UFPRT$$

$$UMAR_i = -11.14 + 1018\ \frac{1}{UPG} + 155.2\ \frac{1}{UMG} + 0.334\ UFPR_i \quad \text{for i = 10 to 14}$$

$$UMAR_i = 47.66 + 789.3\ \frac{1}{UMG} - 1.040\ USG - 0.9316\ ULOW40 + 0.2239\ ULPR_i \quad \text{for 1 = 15 to 19}$$

$$UMAR_i = 52.49 + 0.9786\ UMART \quad \text{for i = 20 to 24}$$

$$UMAR_i = 69.31 + 0.6924\ UMART - 3305\ \frac{1}{INU} \quad \text{for i = 25 to 29}$$

$$UMAR_i = 68.09 + 0.6969\ UMART - 4116\ \frac{1}{INU} \quad \text{for i = 30 to 34}$$

$$UMAR_i = 58.89 + 0.8459\ UMART - 7511\ \frac{1}{INU} \quad \text{for i = 35 to 39}$$

$$UMAR_i = 43.93 + 1.095\ UMART - 9147\ \frac{1}{INU} \quad \text{for i = 40 to 44}$$

$$UMAR_i = 47.85 + 0.8033\ UMART - 15160\ \frac{1}{INU} \quad \text{for i = 45 to 50}$$

$$UEMFRT = 174.5 + 0.4923\ UFL - 0.8172\ UFPRT$$

$$UEMFR_i^t = \left[4250.5 - 147.74\ (i) + 1.391\ (i)^2 - 966236\ (i)^{-2} + 6920430\ (i)^{-3} \right] x \frac{UEMFRT^{t-1}}{UEMFRT^t}$$

This submodel of age at marriage and fertility behaviour (MF) was interfaced with the main India BN model (IBN) to analyse and study the various short and long term socio-economic and demographic consequences of raising age at marriage. The various subsystem of IBN (Economic, Demographic, Education, Employment and labour supply Basic Needs etc.) provide the values of the exogeneous variables appearing in the MF submodel and in turn also use the simulated values of the endogeneous variables of the MF model. Essentially what we have done is to enlarge a part of the demographic subsystem of IBN by independently structuring and constructing a model of the age specific marital and fertility behaviour in rural and urban areas and to interface it with the main IBN model. The detailed structure of the MF model as well as its relation to the IBN model are given in the following flow charts. Total compatibility in terms of data structure and estimation procedure between the MF and the IBN models has been ensured so that the resultant models can be considered as a single simulation model for population policy analysis. Henceforth we will refer to this model as the Population Policy Simulation Model of India (POPSIM).

CHAPTER 5

POPSIM : BASE RUN RESULTS AND EVALUATION OF SELECTED POLICY ALTERNATIVES

Following the design and calibration of POPSIM (Population Simulation Model of India) - undoubtedly a massive task - comes the tedious work of examining and analysing its operation and the patterns of behaviour it reveals. The dynamic interrelationships between variables belonging to different sub-systems become explicit only through the simulation runs. This becomes particularly evident in complex socio-economic models like the present one.

5.1 Initialization of the Model

The simulated future states of the socio-economic system in the next thirty years are obtained by giving values to input variables of the model for some initial year. The outputs for the first year then become inputs for the next year. Thus, each year's results are worked out iteratively. The trajectory of all the output variables describing the dynamic behaviour of the national socio-economic system, given the actual values for initial year variables, is called the Base Run.

The year 1970-71 was chosen as the initial year of the model. The choice was primarily indicated by the fact that most of the data used for estimation was available for that year. It was also a census year, whence the demographic module is securely based. Another advantage of selecting 1970-71 as the base year was that the validity of the model could be established through comparison of simulated output values with the actual data available for a sufficient number of later years.

5.2 Demographic Scenario in 2000 A.D. (Base Run)

The demographic scenario in general depicts an alarming picture in 2000 A.D. even under the assumption of a continued growth of acceptance of family planning methods. (See graph sheet 5.3). Not only the level of population at 1022 million, but also its structure, leads to an explosive situation

Distribution of Population - 1971

Age group	Number (million)						Percent					
	Rural		Urban		Total		Rural		Urban		Total	
	F	M	F	M	F	M	F	M	F	M	F	M
1	2	3	4	5	6	7	8	9	10	11	12	13
0 - 9	64.1	67.5	14.8	15.9	78.9	83.4	30.0	29.9	29.3	27.2	29.9	29.4
10 - 14	25.1	27.3	6.0	7.1	31.1	34.4	11.8	12.1	12.1	12.1	11.8	12.1
15 - 19	20.7	21.9	5.2	6.2	25.9	28.1	9.7	10.4	10.5	10.5	9.8	9.9
20 - 24	17.9	17.9	4.7	5.5	22.6	23.4	8.4	7.9	9.3	9.4	8.6	8.2
25 - 49	62.1	64.4	14.8	18.3	76.9	82.7	29.0	28.7	29.4	31.1	29.1	2911
50 +	23.8	26.4	4.8	5.7	28.6	32.1	11.1	11.7	9.5	9.7	10.8	11.3
Total	213.7	225.3	50.4	58.7	264.1	284.1	100.0	100.0	100.0	100.0	100.0	100.0

Distribution of Population - 2000

Age group	Number (million)						Percent					
	Rural		Urban		Total		Rural		Urban		Total	
	F	M	F	M	F	M	F	M	F	M	F	M
0 - 9	101.4	103.3	30.4	31.7	131.8	135.0	28.1	28.1	21.3	21.0	26.3	26.0
10 - 14	42.4	43.4	15.0	15.8	57.4	59.2	11.8	11.8	10.4	10.4	11.4	11.4
15 - 19	37.2	38.3	14.1	14.7	51.3	53.0	10.4	10.4	9.9	9.7	10.2	10.2
20 - 24	33.4	34.6	13.0	13.7	46.4	48.3	9.3	9.4	9.0	9.0	9.2	9.3
25 - 49	103.7	109.5	49.7	54.0	153.4	163.5	28.8	29.7	34.8	35.7	30.5	31.5
50 +	41.6	39.0	20.6	21.6	62.2	60.6	11.6	10.6	14.4	14.2	12.4	11.6
Total	359.7	368.1	142.8	151.5	502.5	519.6	100.0	100.0	100.0	100.0	100.0	100.0

F = Female M = Male

towards the turn of the century. The level and structure of the population (age-wise and rural-urban breakup) for 1971 and as projected in POPSIM for 2000 is given in Table 1.

The total population crosses the billion mark in2000 and about 54 percent of the total female population will be in its productive span of life (12 to 49) which is higher by 1.5 points compared to 1971. Of the productive female population, 91 million in rural areas and 34 million in urban areas will be in the age group 12 to 24 where the percentage of couples protected by family planning is insignificant (see graph sheet 5.1). This implies that the only way to control fertility among this group, in the absence of large acceptance of family planning methods, is to prevent them from achieving marital status by raising their age at marriage. This warrants us to estimate the probable age-wise distribution of currently married women in 2000.

5.3 Distribution of Currently Married Women in 2000

It can be observed from the graph (graph sheet 5.1) that the percentage of currently married women in 2000 is marginally lower compared to 1971 upto the age of 25 to 27 and thereafter it is significantly higher for the upper ages in rural areas. For urban areas the percentage corresponding to 2000 is lower compared to that of 1971 for all ages, though the differences tend to reduce for higher age groups. Both the results are interesting and reveal that under the existing pattern (in which the relevant policies are those relating to education, labour force participation and income distribution) the increase in the mean age at marriage is marginal in both rural and urban areas. Thus, direct measures (e.g. new legislation, modification of the existing laws and their strict enforcement) and/or indirect measures (compulsary enrolment of girls in school upto a certain level of education, say higher secondary; redistribution of income in favour of the poor, and selected socio-economic incentives such as job reservation or preference, marriage subsides, subsidised educational and health services, etc.) are required to reduce the percentage of girls getting married below the age of 20. Since it is likely to be impossible to raise the minimum age at marriage merely through legislative measures due to its socio-cultural dimensions, a pragmatic approach could be to adopt a combination of methods which might reduce it.

Percentage of girls married in the first three age groups from 1971 to 2000 under the base run is presented in graph sheet 5.3

5.4 Agewise Effective Marital Fertility Behaviour in Rural and Urban 2000 (Base Run)

Agewise effective marital fertility behaviour, as noted in the earlier chapters, is the key factor which links the age at marriage to population growth. Hence it is most important to analyse the age specific effective marital fertility behaviour in 2000 especially among the lower age groups, besides estimating the probability of being effectively protected by any of the family planning methods.

Graph sheet 5-1 compares the agewise effective marital fertility behaviour between 1971 and 2000 for rural and urban. Though there is a marginal reduction in the agewise effective marital fertility behaviour (i.e. number of births per 1000 unprotected currently married women in that age group), the rates corresponding to the lower age groups are still relatively high. Thus, given the fact that even in the year 2000 the percentage of girls getting married is quite high in the lower age groups where they have significant fertility rates, we must analyse the percentage of women protected in the age groups to study their impact on population growth.

5.5 Currently Married Women Effectively Protected by Family Planning Methods

This is a tricky question as the probability of being currently protected depends on her being married upto the current year and the effectiveness of the method the couple adopts. For example on the one hand methods such as vasectomy and tubectomy add the couple to the status of permanently protected, on the other purely temporary methods such as use of contraceptive whose effectiveness is 50 percent or less has to be recurring. A method such as IUD is semi-permanent with a greater degree of effectiveness.

Thus in estimating the total number of women "effectively protected" in each age group in rural and urban in 2000, we had to estimate for every year from 1971 to 2000 the:

1. Number of married women protected* by family planning during that year under each method (sterilisation, IUD and contraceptives) and their effectiveness

2. Age-wise distribution of the married women protected by each method during the year

3. Total number of married women protected during the previous year and carried to the current year (Note that this affects the percentage of protected women in a given age.)

5.6 Total Number of Currently Married Women Protected Under Various Family Planning Methods (Graph sheet 5.3)

An optimistic trend based on the seventies is assumed for currently married women protected under sterilisations, IUD and contraceptives including pills, from 1981 to 2000. The pattern of growth is also assumed to be the same for the rural and urban areas. Presently this is an exogeneous factor to the model and the model POPSIM could equally well be simulated for any 'slow','medium' or 'high' family planning scenario.

5.7 Distribution of the Age of the Wife Among the Couples Freshly Protected by Sterilisation, IUD and CCU

Due to lack of data, the agewise distribution of currently married women protected by IUD is assumed to be the same. The change in the distribution for fresh sterilisation and other methods over the years is estimated using the time-series data available for the seventies for different age groups. This shows a favourable shift in thedistribution especially for sterilisation towards the more fertile ages. (For example compared to 5.3 percent in 1971 it has gone up to 11.9 in 2000 in age 26.) Since the rural-urban break up of such data is not available, the same distribution has been assumed for rural and urban.

Thus the dismal demographic scene of 2000 A.D. portrayed earlier has to be viewed in the context of the assumption of a significant growth in the

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* i.e. the additional number of couples protected during that year

number of married women protected as well as an increasingly favourable distribution of newly protected women towards the most fertile age group (22 to 35). A lower rate of growth than the one assumed and/or a higher percentage of women in the upper age group among the newly protected could make the scene even more gloomy.

5.8 Agewise Distribution of Protected Married Women in 2000

From the population policy point of view, age at marriage has to be linked to the age distribution of the total protected married women. For example a higher percentage of women getting married in a specific age need not necessarily affect the population growth if the share of protected married women is also sufficiently high in that age. Hence it is imperative to find out the pattern of acceptability of family planning in the lower age group.

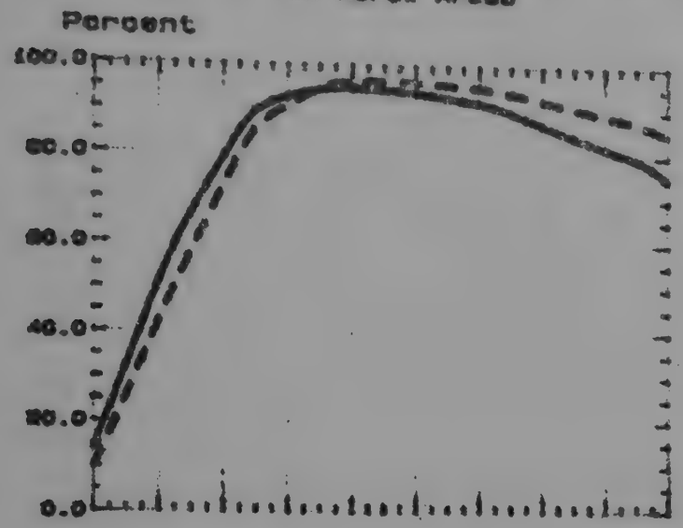
Graph 5.1 shows that the percentage of protected married girls in the lower age group is very low in both rural and urban. It is significant that even at the age of 22 it is as low as 5 percent. However, due to the permanent and semi-permanent family planning methods, the percentage of protected married women progressively increases in the upper age groups both in rural and urban areas.

Thus the high percentage of girls getting married in the lower age groups and their significant fertility rates combined with the extremely low acceptance of family planning methods at these ages make age at marriage a major policy instrument to control India's population growth. However, this is a supplementary measure rather than a substitute for the existing family planning programmes. Graph 5.2 substantiates this.

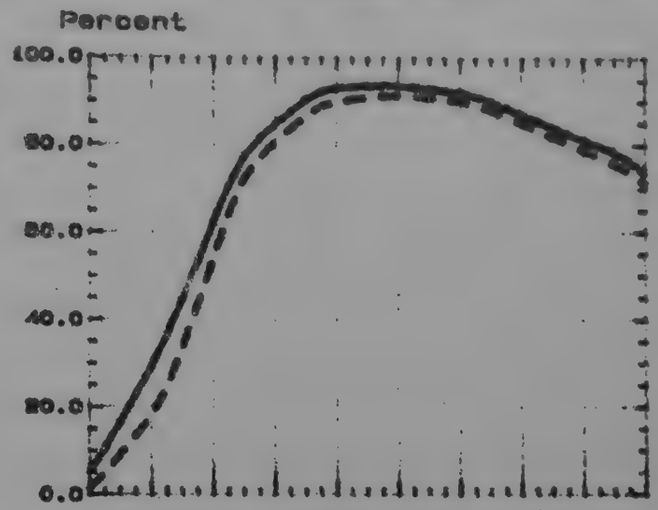
The total number of births averted from 1971 upto 1980 by family planning methods in the rural areas works out to be 24 million. It is estimated that the total number of births averted from 1971 to 2000 will amount to 141 million if three of every ten married women are protected by that time. However, the total births averted due to the normal rise in the age at marriage from 1971 to 1980 is only a million, which goes up only to 12 million in 2000 - about 8.5 percent of the cumulative total births averted by Family Planning.

GRAPH SHEET 5.1

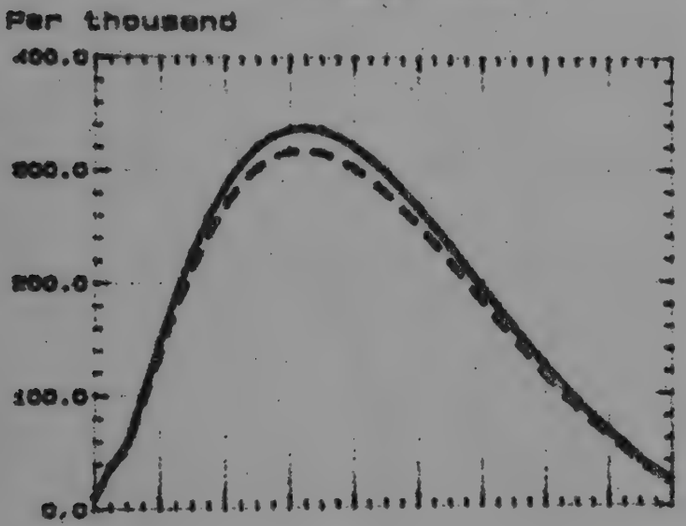
Percentage of Women Married
in Rural Areas



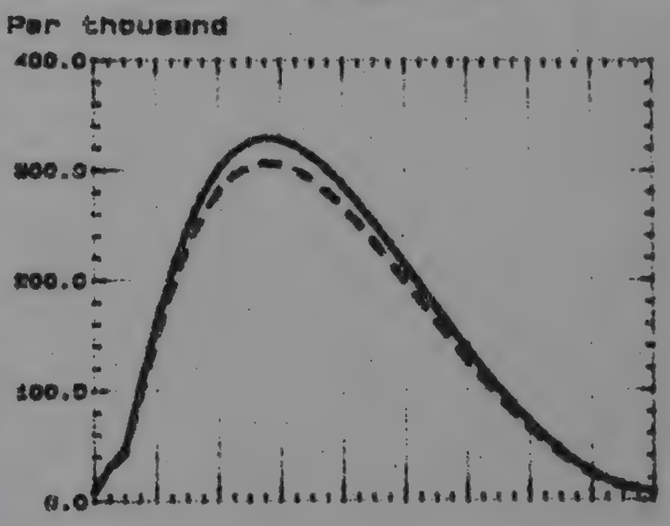
Percentage of Women Married
in Urban Areas



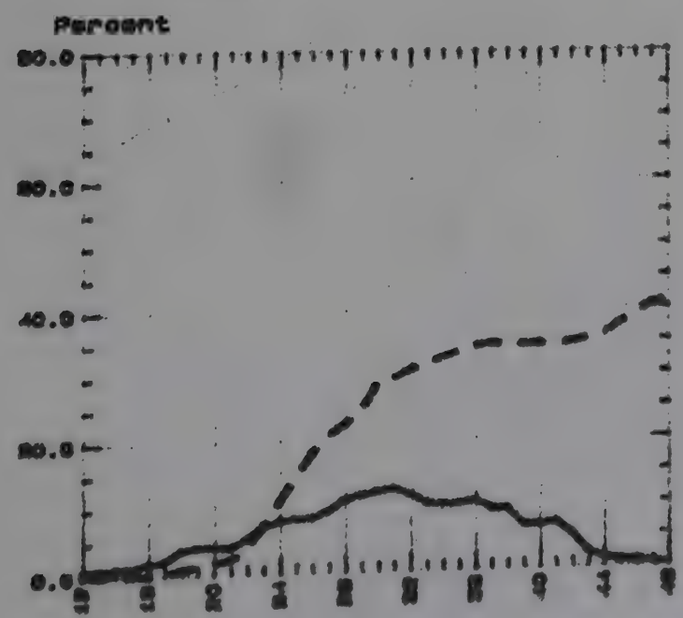
Effective Marital Fertility
in Rural Areas



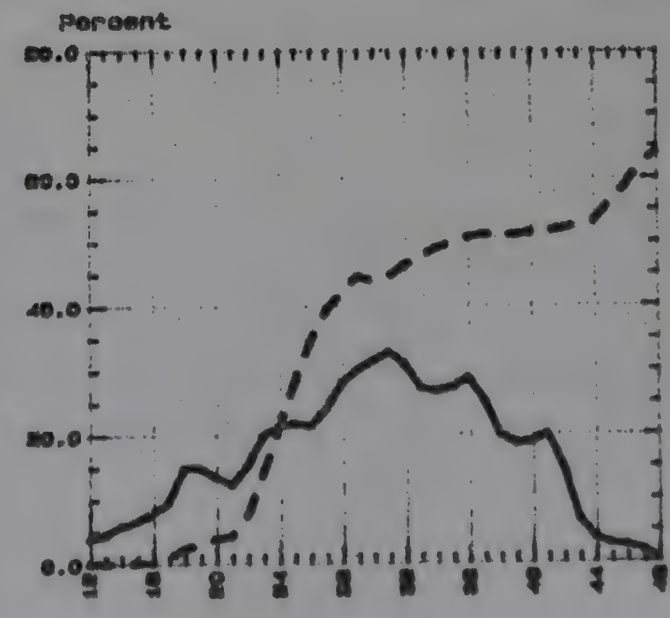
Effective Marital Fertility
in Urban Areas



Percentage of Married Women
Protected by F. P. Methods (Rural)



Percentage of Married Women
Protected by F. P. Methods (Urban)

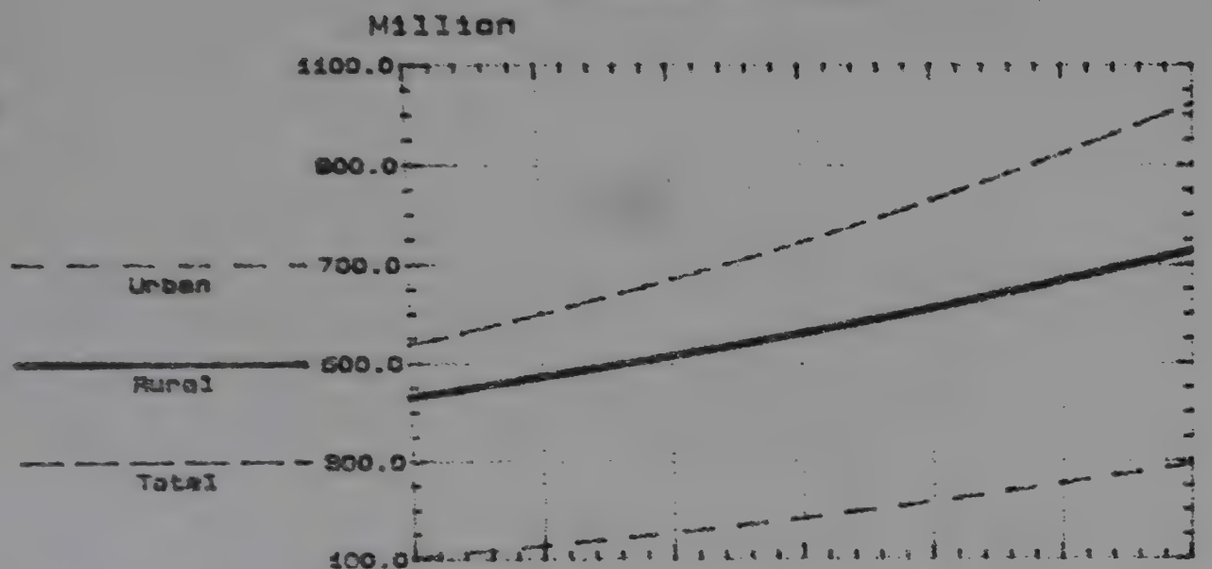


Age Year
——— 1971

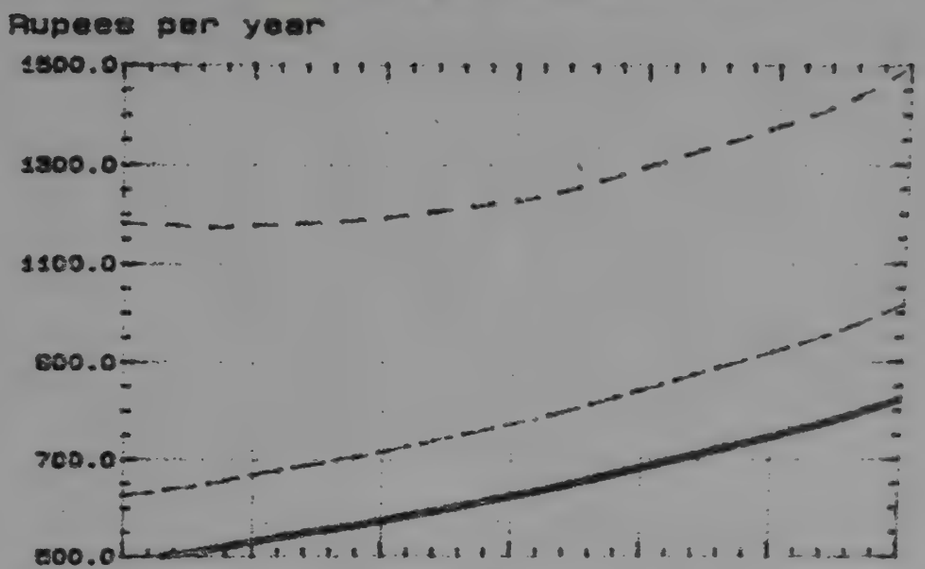
Age Year
- - - - - 2000

GRAPH SHEET 5.2

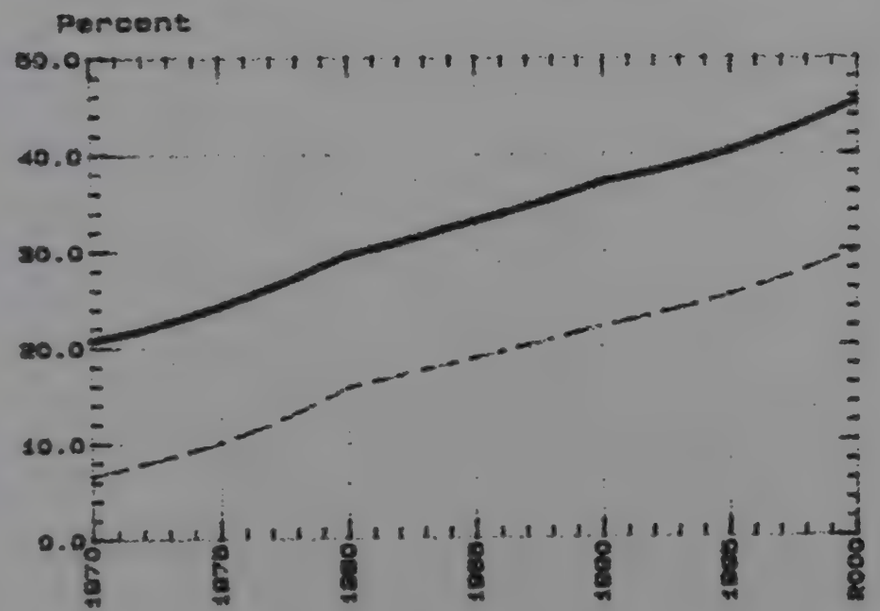
Population
Rural, Urban and Total



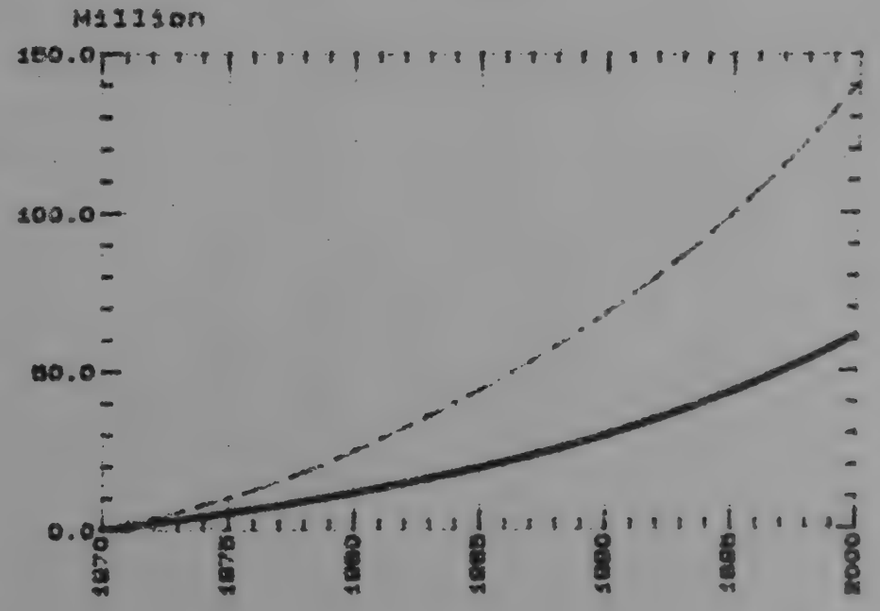
Per Capita Income
Rural, Urban and Total



Percentage of Married Women
Protected by F. P. Methods



Cumulative no of births averted
by F. P. Methods



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The total number of births averted from 1977 to 2000 in urban areas works out to be 61 million by family planning methods (assuming that every second married women is protected) and 8 million by rising age at marriage.

Thus in the absence of pr gmatic efficient and effective policies to control the age at marriage, family planning will continue to be the major policy instrument available to planners and policy makers to tackle the population growth.

5.9 Simulation of POPSIM for Selected Strategies to Reduce Age at Marriage

Strategy 1 : India achieves Kerala's 1971 Pattern of Age at Marriage by 1990

The percentage of girls getting married in the lower age groups in rural and urban India is made to follow that of Kerala in 1971. The change is introduced during the eighties so that by 1990 India would have achieved that prevailingin Kerala in 1971. (The rates are not permitted to go above these, thereafter.) At the outset this appears to be not too optimistic. Here we are primarily concerned with the question that if India could achieve this, what would be the demographic and socio-economic implications in the following 10 years till 2000. (Note that this will also depend on the method by which this is achieved. This aspect will be taken care of in the subsequent policy runs). The following table presents the underlying assumptions:

Percentage of girls married

	Rural			Urban		
Age	10 - 14	15 - 19	20 - 24	10 - 14	15 - 19	20 - 24
Year						
1983	17.7	55.6	88.0	3.5	31.6	75.1
1990	1.0	18.0	65.0	0.1	13.0	60.0

The results are presented in table 2 and in the graphs as short light dashes.

Strategy 2 : Raising school enrolment rates for India by 1990 to the level in TN, Punjab, and Kerala in 1981.

As noted in chapter 2, the school enrolment rate appeared to be, in our analysis of the data, the most significant factor affecting the percentage of girls getting married in the lower age groups in rural and urban areas. It was also observed that, in general, states having a higher secondary school enrolment rate for girls also have a low marriage rate of girls in the lower age groups. In this scenario we run POPSIM to evaluate the socio-economic and demographic implications of bringing the average school enrolments in rural and urban India in 1990 to around the present level (1981) and slightly above the 1971 level of Kerala, Tamil Nadu and Punjab.

The enrolment rates of girls and boys in primary, middle and higher secondary in rural and urban areas are progressively increased from 1983 to the target level at 1990 and the rates are maintained thereafter as follows:

Enrolment Rates

Year		1983		1990	
		Girls	Boys	Girls	Boys
Rural					
	Primary	45	76	95	97
	Middle	14	35	50	70
	H. Secondary	4	16	15	30
Urban					
	Primary	79	90	97	98
	Middle	31	44	65	80
	H. Secondary	15	32	40	60

Though the above levels for 1990 seem to be very low and quite within the feasible range, their achievement will be a herculean task for the government as the 1983 rates for middle

and higher secondary school are only a fraction of the corresponding targets. However, achievement of these rates is technically feasible, and could well form the basis of a strategy for government.

The simulated results are presented in Table 2 and in the graphs as long light dashes.

Strategy 3 : India Achieves the 1971 Kerala literacy rates in 1990

It was observed in chapter 2 that literacy (mostly via female enrolment rates) is a key factor that affects the percentage of girls getting married in lower age groups. Literacy is also an important parameter in the economic modules of POPSIM. This scenario simulates the outcome of an all round effort to increase the overall literacy rates on the age at marriage, as well as its other consequences.

Male and female literacy rates in rural and urban areas (%)

	Rural		Urban	
Year	Female	Male	Female	Male
1983	18	40	48	66
1990	50	70	70	80

Raising rural female literacy from 18 in 1971 to 50 in 1990 is, of course, next to impossible unless a combination of very effective administrative measures, formal and non-formal, are undertaken and also a series of incentives is offered.

Note the economic implications of this strategy. The main results are presented in table 2, and in the graphs as short thick dashes.

Strategy 4 : Higher literacy along with better school enrolment rates

A combination of promoting adult literacy along with better school enrolment rates could be a very effective policy package as these policies reinforce one another. The targets for enrolment rates have been kept the same as in Strategy 2, but that of literacy rates have been substantially reduced from Strategy 3 as follows. The literacy rates are not permitted to fall below thereafter:

Literacy Rates

	Rural		Urban	
Year	Female	Male	Male	Female
1990	35	50	60	70

In the absence of separate equations for adult literacy rates the proposed changes are made in the over-all literacy rates. Hence the induced enrolments by themselves will enhance the literacy levels so that only a fraction of the proposed target levels have to be met by promoting adult literacy. The simulated results are presented in table 2 and in the graphs as a thin solid line.

5.10 Main Findings

Table 2 and graphs 5.4 to 5.8 shed light on certain fundamental linkages among the demographic, economic and social factors of the system. Strategies one, two and four are comparable in the sense that they avert more or less the same number of births due to a rise in the age at marriage, but their impact on most of the other variables in the system are significantly different. For example, while strategy one (direct progressive reduction in the percentage of women married) reduces the total population in 2000 by about 56 million from 1022 million to 966 million, the other two reduce it by about 78 to 80 million. This is due to the fact that while strategy one affects the population only via the reduced birth due to rise in age at

marriage, the other two reduce the population growth by a decline in the over-all fertility level as well.

The above result is extremely important for formulating effective population policies. The direct control of age at marriage (e.g. by effective legal measures) can bring only limited reduction in the population growth besides generating a lot of social tensions. On the other hand a rise in the age at marriage, if brought out by controlling certain related factors like literacy and education could curtail the population growth more effectively. It should be noted that the two strategies are qualitatively different. Strategy one is artificial in nature while strategies two and four already lie on the natural growth path, but they reach the targets in a shorter period. The basic difference between them is that under strategies two and four, girls could take advantage of the additional years they are getting due to the delayed marriage.

Under strategy three (higher literacy rate) even though the number of births averted by rising age at marriage is only two thirds of that under other strategies, its effect on total population is similar to that of strategies two and four.

Two anomalies that may be seen in the demographic results are the marginally higher death rate under strategy three, compared to that in the base run, and the relatively lower percentage of the girls getting married in the age group 20 to 24 in rural areas compared to that in the urban areas under strategies two and four. The former one appears due to the way the death rate is computed using life expectancy and survival probabilities from Coale-Demeny tables (where the equation for life expectancy uses the FLFPR, thus leading to the noted result when FLFPR falls), and the latter one due to a linear functional relationship between percentage of married girls in that age group and secondary school enrolment rate possibly due to too small a difference between the enrolment rates in urban and rural.

The conclusions drawn regarding the relatively favourable effect of the four strategies is more or less applicable to their effect on the economic and income distribution system. Under strategies two to four the economy

grows rapidly. The rapid growth of the economy is also reflected in its structural transformation measured by the changing share of sectoral outputs and the patternof allocation of household expenditure on food, manufacturing and services. It should be noted that all rupee figures are based on the 1970-71 prices and as such caution should be exercised in comparing variables such as total exports and imports for base run for any given strategy. However, such comparisons are less problematic as between the base run and the strategies.

A notable feature of these strategies is their favourable effect on employment as can be seen from graph sheet 5.5. In general it can be observed that a higher growth rate of the economy requires a relatively large import components, possibly to satisfy the investment demand. It should be noted that the key factor in this growth is the increased propensity to save, and hence invest, due to a slow but steady reduction in the growth of population. This stage appear to be the "Take Off" stage of the economy where growth in the social infrastructure and in the economy reinforce each other ahd lead to further higher growth.

In terms of their favourable influence on the selected basic needs and indicators of development (table 2) the strategies can be ranked in the order of strategy four and two followed by strategy three and one. Indeed, there is very little difference between strategies four and two so far as their effect on the basic needs and development indicators are concerned.

A notable feature is that the per capita private expenditure on basic needs (including education, health and housing, but excluding food) in rural area is highest under strategy three. This is hardly surprising as the literacy rate,a major factor that determines the private expenditure on basic needs in rural areas is also highest under this strategy. The index of commercial energy availability also shows similar pattern.

It is difficult to evaluate the strategies to find out the best or "most effective" one from the social and economic benefit-cost point of view as the present model does not compute factors such as financial or physical - or administrative - resources required to achieve a given level of male

and female literacy and enrolment rate of boys and girls in primary, middle or higher secondary levels in rural and urban. The share of private expenditure in total expenditure as education may increase from lower to higher levels and hence to some extent will affect the household expenditure pattern. Similarly, pattern of government expenditure and employment etc. will also be affected. Therefore, due to the interdependent nature of the system, the direct and undirect cost and benefits have to be traced through a number of variables. Presently the strategies can be evaluated only in relation to their effect on selected output variables as given in table 2 and graph sheets 4 to 8.

In general, strategies two to four point towards the fact that the key to India's socio-economic development lies in the control of its growing population. Undoubtedly, family planning is the number one strategy to deal with this problem. However, even assuming an 'optimistic' share of couples protected by different family planning methods (graph sheet no. 5.1) it is estimated that India's total population is likely to cross the billion mark by 2000 A.D. An enhanced family planning programme could of course, form a potential strategy to deal with this situation, but is by no means the most effective one. For, part of the problem is caused by the fact that the percentage of married women protected by family planning methods is too low in the lower age groups, and if past trend are any indication, then they will even decline further.

Thus, a revised and enlarged family planning programme along with a strategy for raising the age at marriage of females should be considered as one of the best ways to control India's population growth and to stimulate the socio-economic development of the country. The most important advantage of such strategies is that they appear to be quite stable and self-regulating later and are capable of putting the economy on the "take-off" track

TABLE 2. A COMPARISON OF BASE RUN AND THE FOUR SELECTED STRATEGIES (YEAR 2000)

Demographic Outcomes		Base Run (B.R)	Strategy 1 Actuals	Strategy 1 % Change from B.R	Strategy 2 Actuals	Strategy 2 % Change from B.R	Strategy 3 Actuals	Strategy 3 % Change from B.R	Strategy 4 Actuals	Strategy 4 % Change from B.R
Total Population	(Mil)	1022.1	966.6	-5.48	944.2	-7.6	945.1	-7.5	941.4	-7.9
Rural Population	"	727.8	681.1	-6.4	653.8	-10.2	642.7	-11.7	650.5	-10.6
Urban Population	"	294.3	285.5	-3.0	290.4	-1.3	302.3	2.7	290.9	-1.1
Population under age 15	(%)	35.3	31.5	-10.9	29.8	-15.6	30.0	-15.0	29.7	-16.0
Crude birth rate per (1000)		28.2	24.3	-13.9	22.5	-20.1	23.4	-16.9	18.8	-8.8
Crude death rate per (1000)		14.4	13.8	-4.0	14.15	-1.6	15.2	5.8	14.0	-2.4
Currently married women in										
12 to 15 Rural	(%)	9.8	1.0	-89.8	3.4	-65.3	6.5	-33.5	3.5	-63.9
12 to 15 Urban	"	1.5	0.1	-93.1	0.0	-100.0	1.2	-17.3	0.2	-86.5
16 to 19 Rural	"	50.9	18.0	-64.7	12.7	-75.2	30.6	-39.9	12.9	-74.6
16 to 19 Urban	"	23.9	16.0	-33.1	5.2	-78.4	20.4	-14.6	7.8	-66.6
20 to 24 Rural	"	85.9	65.0	-24.3	65.4	-23.8	74.9	-12.8	65.5	-23.7
20 to 24 Urban	"	73.2	60.0	-18.0	73.1	-0.2	69.7	-4.8	73.7	0.7
No. of birth averted due to rise in age at marriage										
Current year - Rural	(Mil)	0.8	4.8	471.7	4.9	480.4	2.9	237.8	4.9	472.8
Since 1971 - Rural	"	11.9	67.5	469.6	68.5	477.88	44.6	276.6	69.1	482.7
Current year - Urban	"	0.6	1.5	123.3	1.2	86.2	1.0	57.6	1.1	72.5
Since 1971 - Urban	"	8.2	18.5	123.9	17.0	106.4	13.9	68.3	16.7	102.7

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Selected Economic Outcomes		Base Run (B.R)	Strategy 1 Actuals	Strategy 1 % Change from B.R	Strategy 2 Actuals	Strategy 2 % Change from B.R	Strategy 3 Actuals	Strategy 3 % Change from B.R	Strategy 3 Actuals	Strategy 3 % Change from B.R
Gross domestic product	(Rs.Mil)	1040230	1275468	22.6	1594878	53.3	1553493	49.3	1628660	56.6
Govt. Tax revenue	"	187078	229614	22.7	287768	53.8	280225	49.8	293867	57.1
Agricultural Output	"	481548	560013	16.3	660922	37.3	648520	34.7	672927	39.7
Manufacturing output	"	362882	463276	27.7	622358	71.5	596328	64.3	636255	75.3
Services output	"	195799	252179	28.8	311597	59.1	308645	57.6	319478	63.2
Total exports	"	68342	59627	-12.8	59986	-12.2	60845	-11.0	59748	-12.6
Total imports	"	18839	76809	307.7	83493	343.2	85371	353.2	91330	384.78
H. hold consumption of food	(%)	59.4	57.0	-4.0	55.5	-6.7	55.6	-6.4	55.3	-6.9
H. hold manufacturing	"	20.4	20.4	-.2	20.7	1.2	20.7	1.4	20.7	1.4
H. hold services	"	20.1	22.6	12.1	23.8	18.4	23.7	17.6	24.0	19.0
Income & Income Distribution										
Per capita income - All India	(Rs)	1017.7	1319.5	29.7	1689.1	66.0	1643.8	61.5	1730.0	70.0
Per capita income - rural	"	824.0	1044.1	26.7	1299.8	57.7	1298.7	57.6	1332.1	61.7
Per capita income - urban	"	1496.7	1976.6	32.1	2565.8	71.4	2377.5	58.8	2619.7	75.0
Income per ad. eqn. All India	"	1236.1	1565.9	26.7	1985.2	60.6	1934.2	56.5	2031.3	64.3
Income per ad. eqn.- rural	"	1015.3	1253.9	26.7	1540.4	51.7	1548.0	52.5	1576.6	55.3
Income per ad. eqn.- urban	"	1756.4	2284.0	30.0	2960.6	68.6	2745.5	56.3	3022.4	72.1
Share of wage in value added	(%)	26.3	27.5	4.3	28.6	8.4	28.5	8.2	28.7	8.9
Mean wage pay - rural	(Rs)	1689.8	1887.3	11.7	2114.5	25.1	2104.5	24.54	2151.6	27.3
Mean wage pay - urban	"	4689.3	5607.8	19.6	6864.8	46.4	6697.6	42.8	6955.6	48.3
Agricultural labour	(%)	62.8	62.2	-.8	61.7	-1.8	61.5	-2.0	61.4	-2.2

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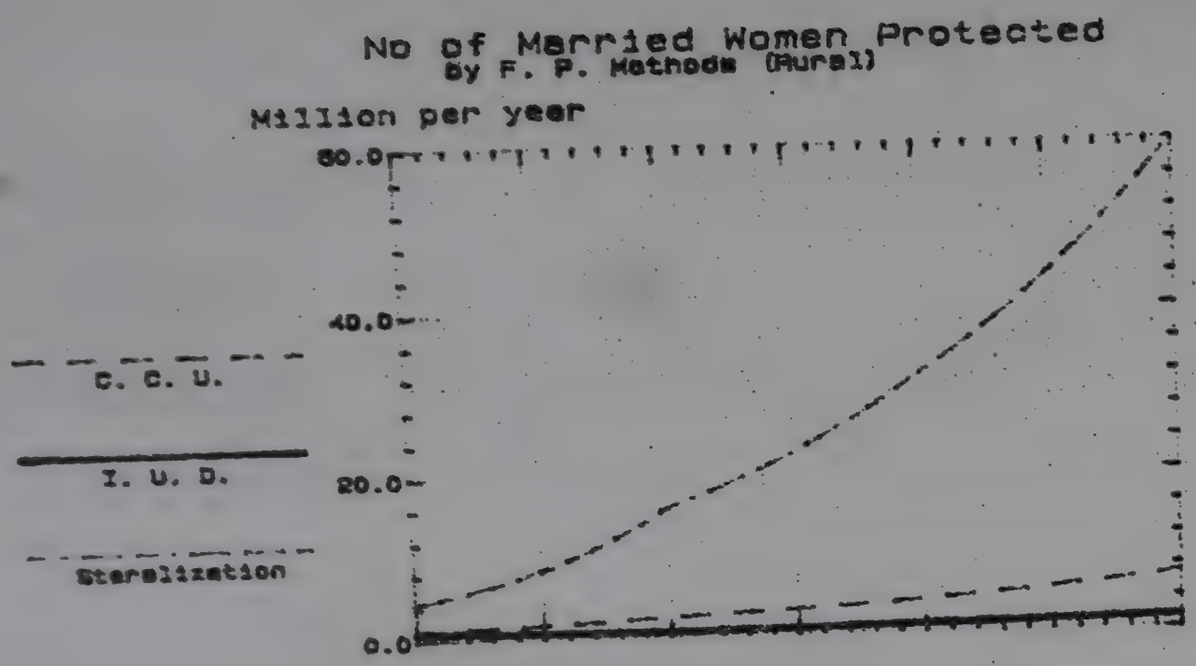
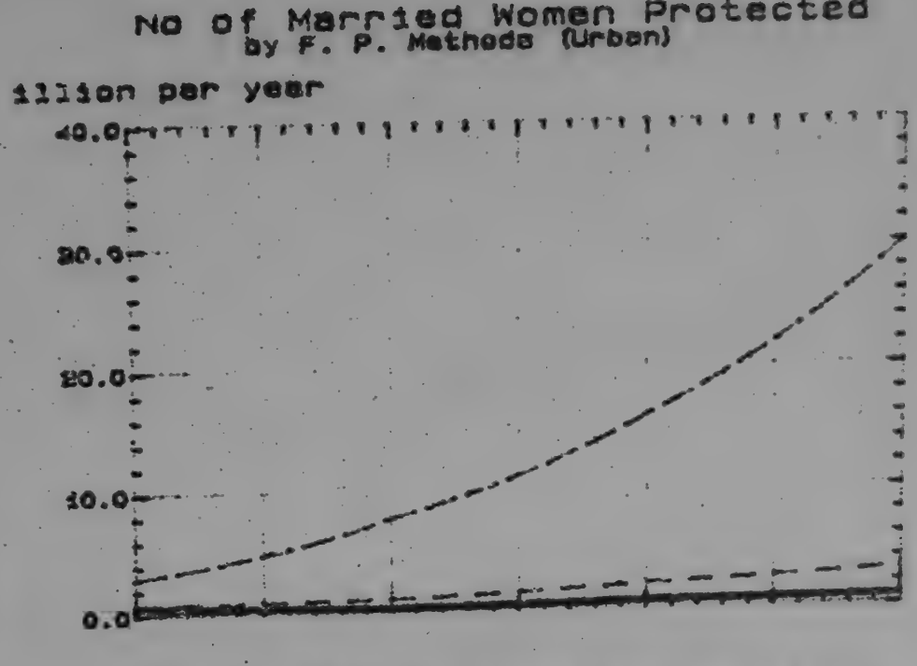
Basic Needs and Selected development indicators	Base Run (B.R)	Strategy 1		Strategy 2		Strategy 3		Strategy 4	
		Actuals	% Change from B.R	Actuals	% Change from B.R	Actuals	% Change from B.R	Actuals	% Change from B.R
Female life expectancy	64.2	67.4	4.9	70.0	9.0	69.6	8.4	70.5	9.7
Female literacy rate - (rural)	23.7	24.5	3.4	40.1	68.9	50.0	110.8	40.1	68.9
Male literacy rate - "	49.1	50.0	2.0	54.8	11.6	70.0	42.6	54.8	11.6
Female literacy rate - (urban)	56.2	57.3	2.0	61.7	9.8	70.0	24.5	61.7	9.8
Male literacy rate - "	75.4	81.3	7.9	88.1	16.9	86.7	15.1	89.0	18.0
Over-all illiteracy rate - (%)	55.0	53.0	-3.5	43.9	-20.0	34.0	-38.2	43.8	-20.4
Child participation rate in labour force (aged less than 15)									
Girls - rural (%)	8.0	7.9	-1.9	5.0	-38.2	3.1	-61.4	5.0	-38.2
Boys - rural "	23.3	21.3	-8.7	17.1	-26.7	19.0	-18.7	16.9	-27.4
Girls - Urban "	2.5	2.7	6.4	2.7	7.1	2.3	-9.7	2.7	8.2
Boys - Urban "	4.4	3.3	-23.5	1.7	-60.1	0.8	-81.8	1.6	-63.0
Per capita private expenditure on education, health and housing (Rs)									
- rural	82.0	104.5	27.5	132.3	61.5	141.7	72.9	136.0	65.9
- urban	163.9	249.6	52.3	347.5	112.0	325.0	98.2	360.1	119.6
Commercial energy availability index	0.4	0.5	25.4	0.4	17.1	0.5	40.5	0.5	21.8

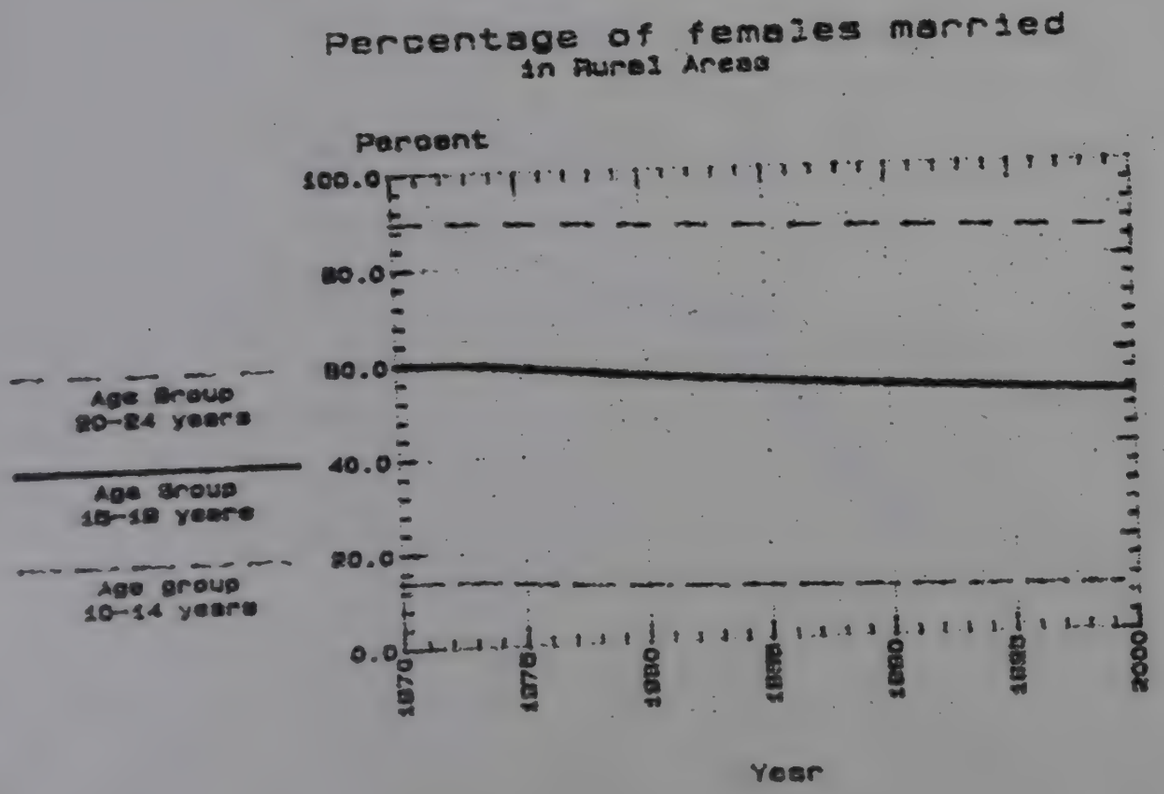
..... contd.

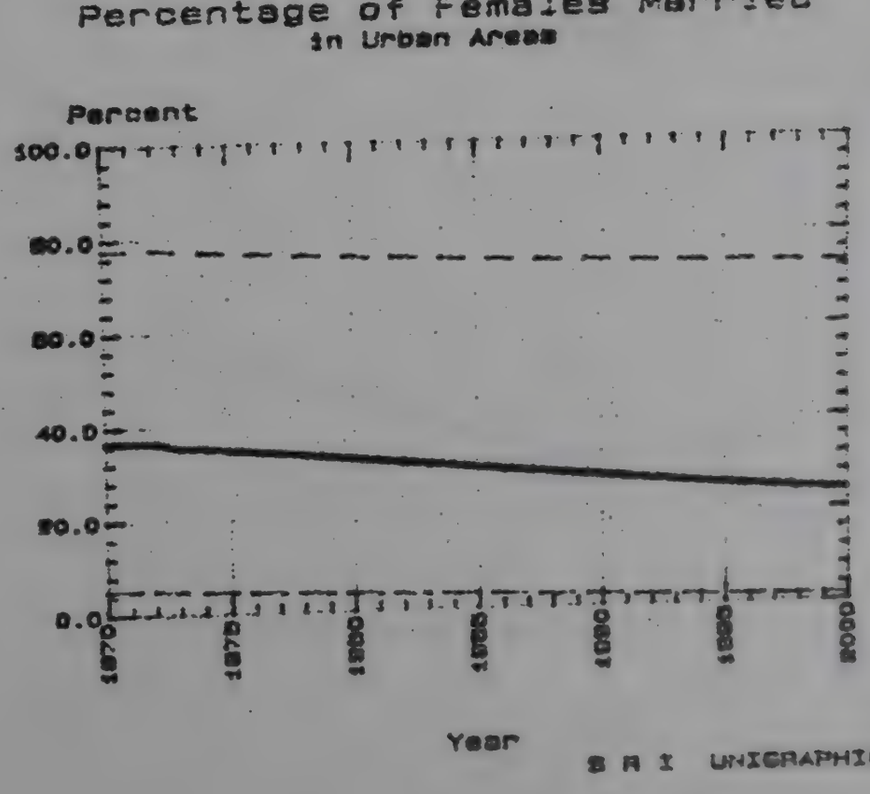
Enrolment Rates		Base Run (B.R)	Strategy 1		Strategy 2		Strategy 3		Strategy 4	
			Actuals	% Change from B.R	Actuals	% Change from B.R	fActuals	% Change from B.R	Actuals	% Change from B.R
Primary - Girls	(Rural)	52.0	54.3	4.4	95.0	82.8	60.7	16.7	95.0	82.8
Middle - Girls	"	17.9	18.9	5.4	50.0	179.3	22.5	25.4	45.0	151.3
H.Secondary Girls	"	5.6	5.8	2.9	15.0	166.3	10.5	87.1	15.0	166.2
Primary - Boys	"	83.7	86.2	3.0	97.0	15.9	92.6	10.7	97.0	15.9
Middle - Boys	"	41.3	43.1	4.3	70.0	69.4	48.0	16.1	70.0	69.4
H.Secondary Boys	"	18.7	19.0	1.7	30.0	60.8	21.4	14.9	30.0	60.8
Primary - Girls	(Urban)	86.4	89.0	3.0	97.0	12.2	94.4	9.2	97.0	12.2
Middle - Girls	"	38.5	41.0	6.8	65.0	68.8	44.1	14.5	65.0	68.8
H.Secondary Girls	"	18.7	20.0	6.9	40.0	113.4	21.2	12.9	30.0	60.1
Primary - Boys	"	95.2	97.1	2.0	99.7	4.7	101.0	6.2	99.9	4.9
Middle - Boys	"	49.6	51.2	3.4	80.0	61.4	53.8	8.5	80.0	61.4
H.Secondary Boys	"	36.3	37.8	4.0	60.0	65.2	39.3	8.1	60.0	65.2

GRAPH SHEET 5.3









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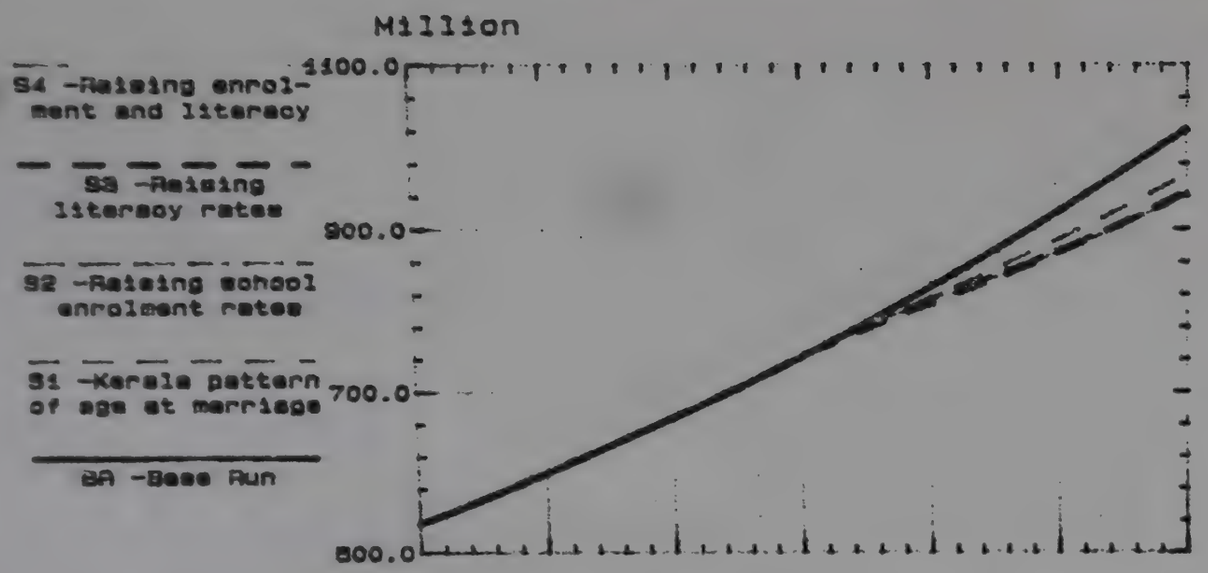
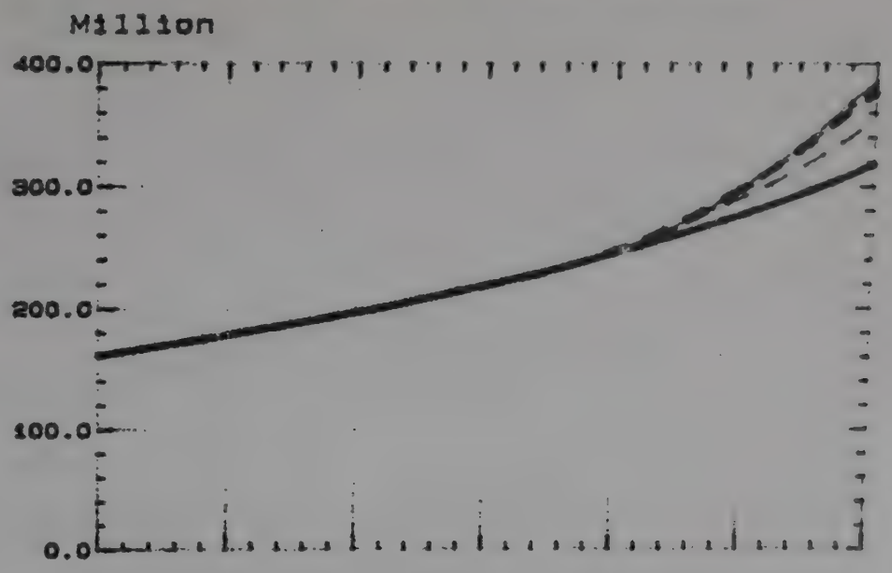
GRAPH SHEET 5.4

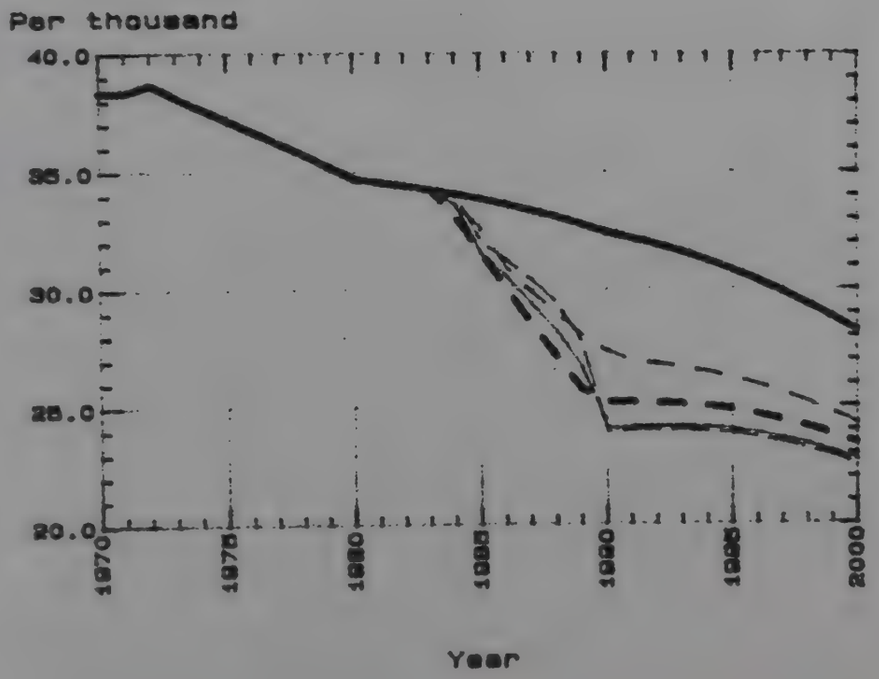
Total Population



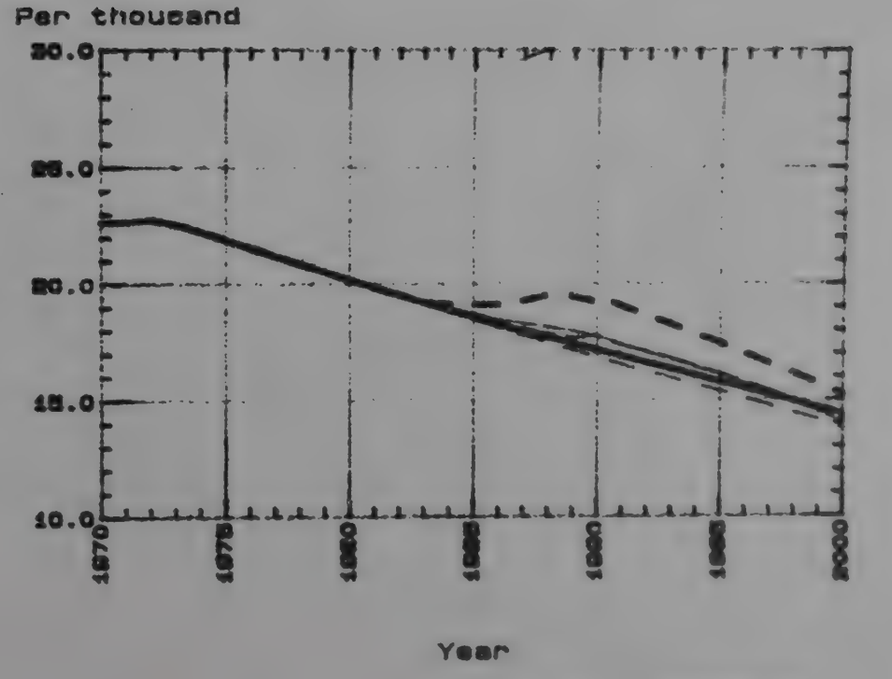
Total Working Population



Crude Birth Rate

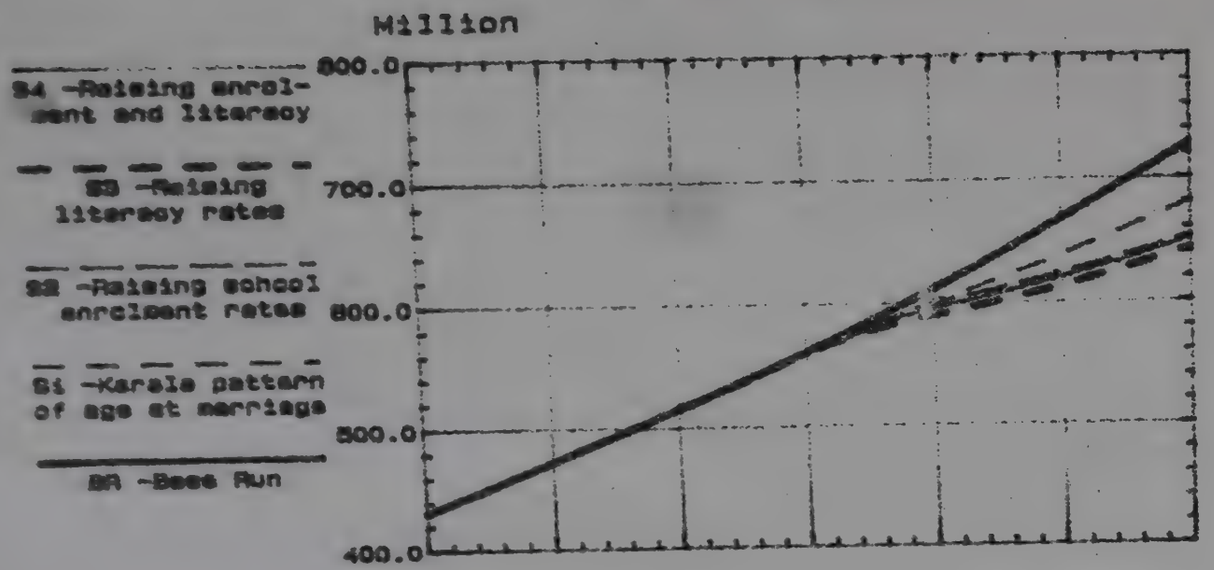


Crude Death Rate

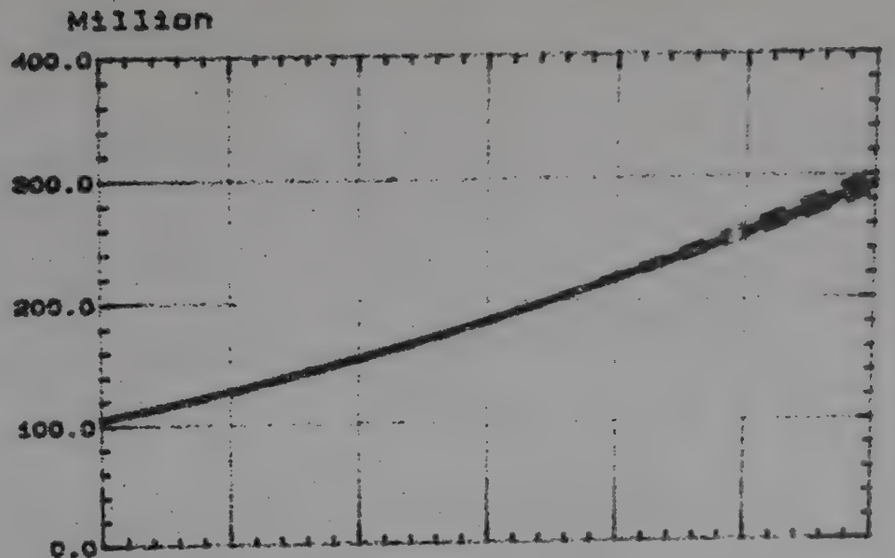


GRAPH SHEET 5.5

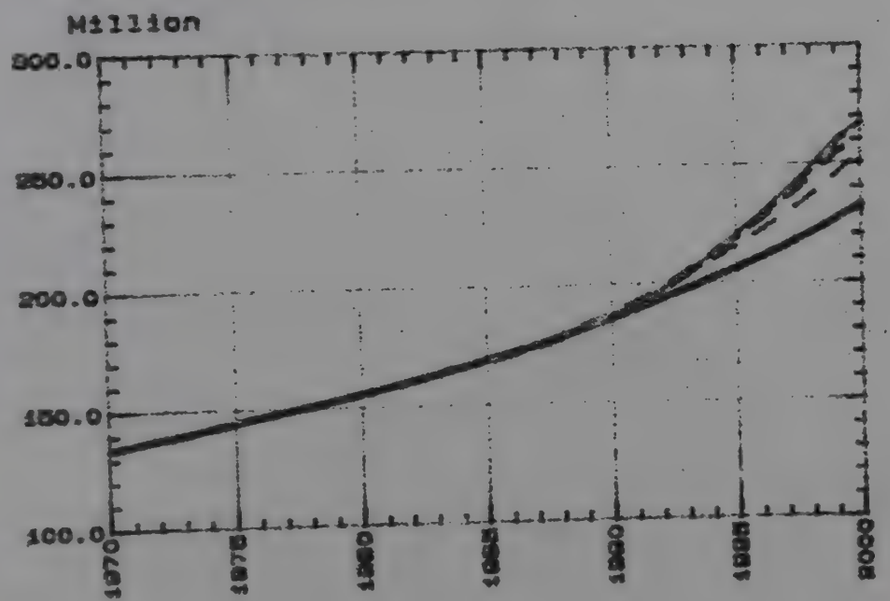
Rural Population



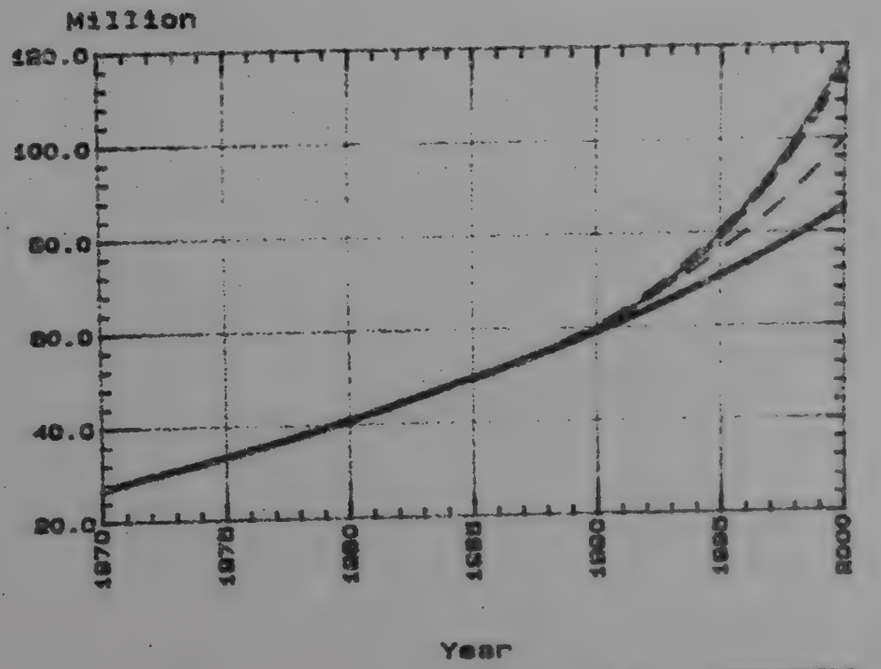
Urban Population



Number of Persons Employed in Rural Areas

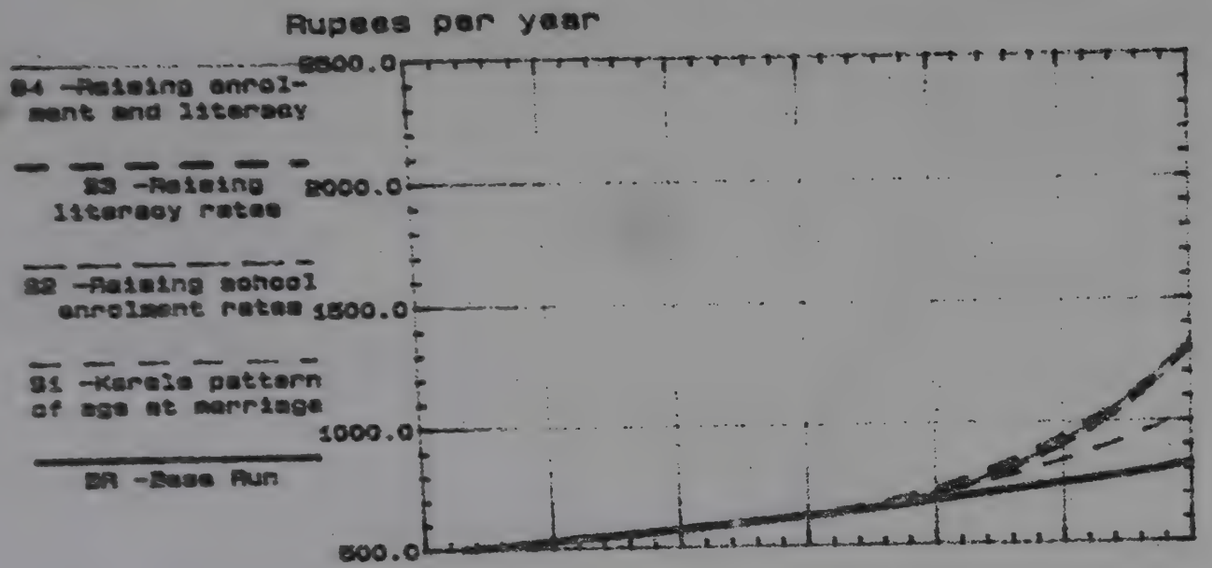


Number of Persons Employed in Urban Areas

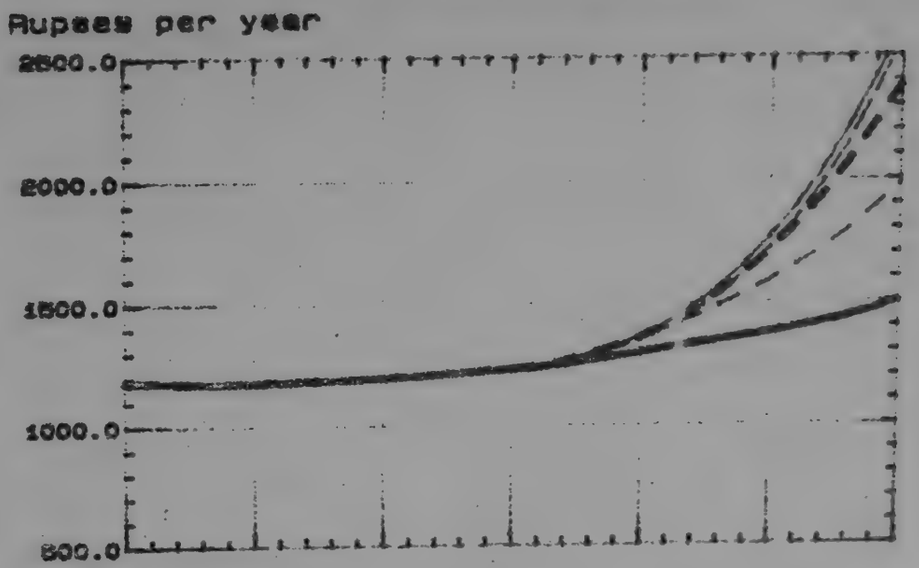


GRAPH SHEET 5.8

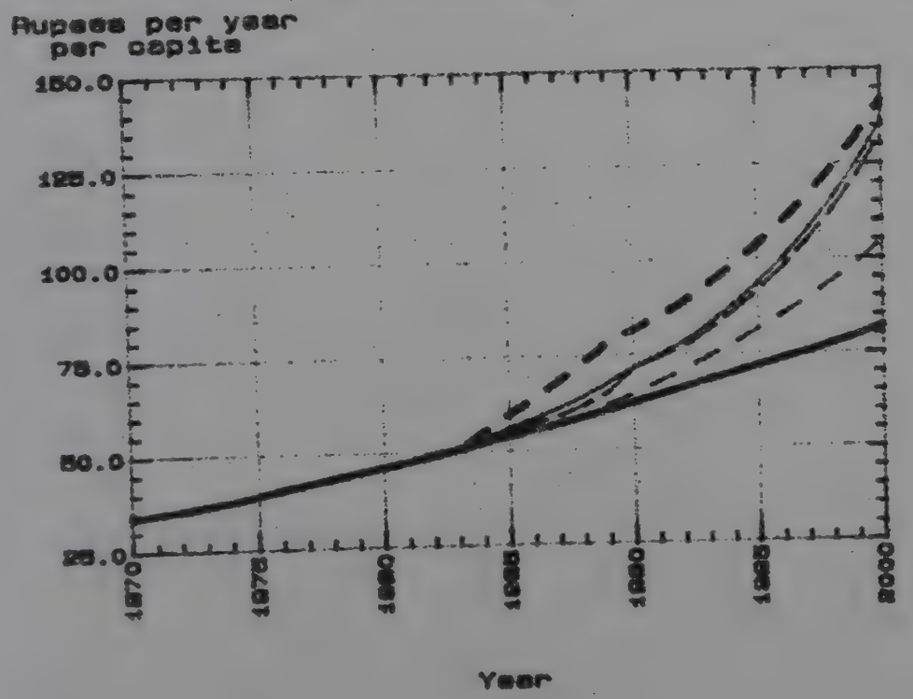
Rural Per Capita Income



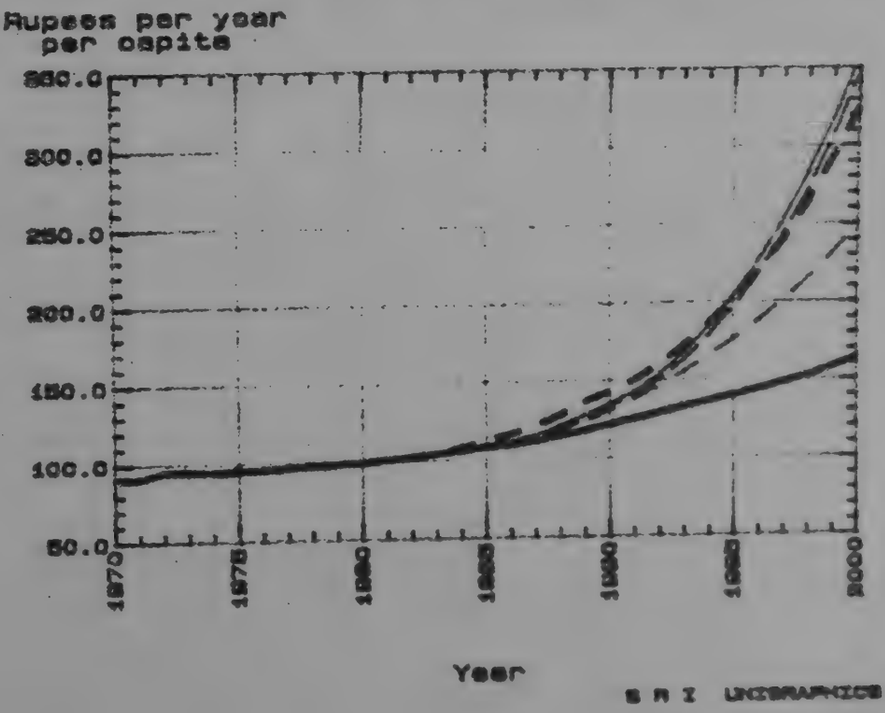
Urban Per Capita Income



Private Expediture on Basic Needs in Rural Areas



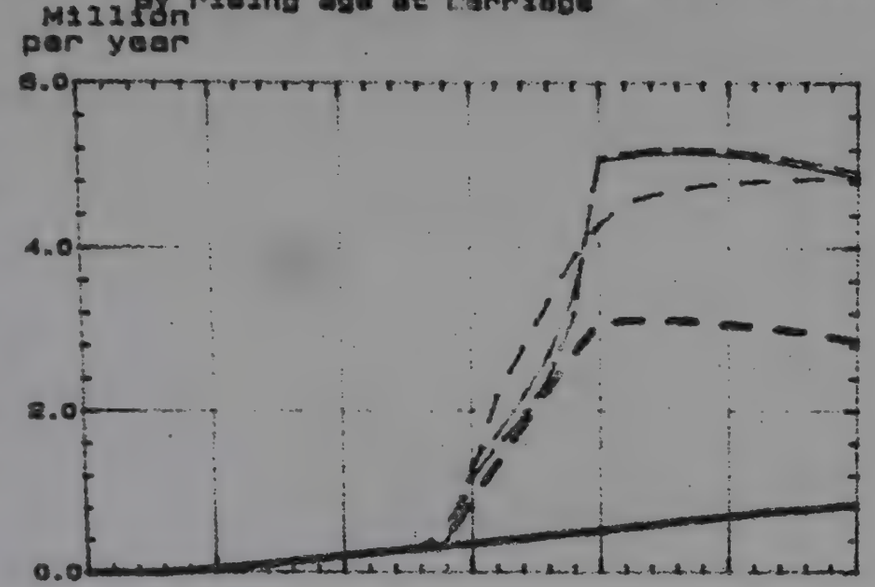
Private Expenditure on Basic Needs in Urban Areas



S R I UNIGRAPHICS

GRAPH SHEET 5.7

No of births averted in Rural Areas
By rising age at marriage



S4 -Raising enrolment and literacy

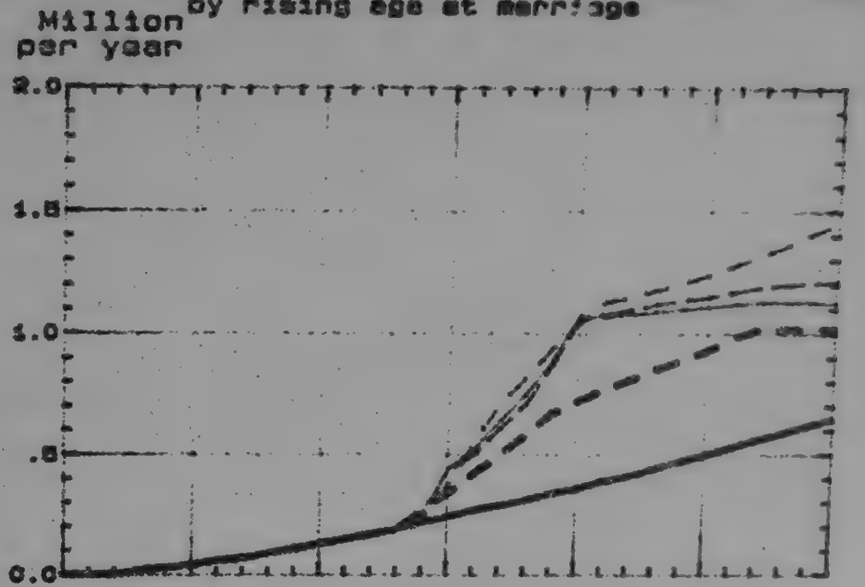
S3 -Raising literacy rates

S2 -Raising school enrolment rates

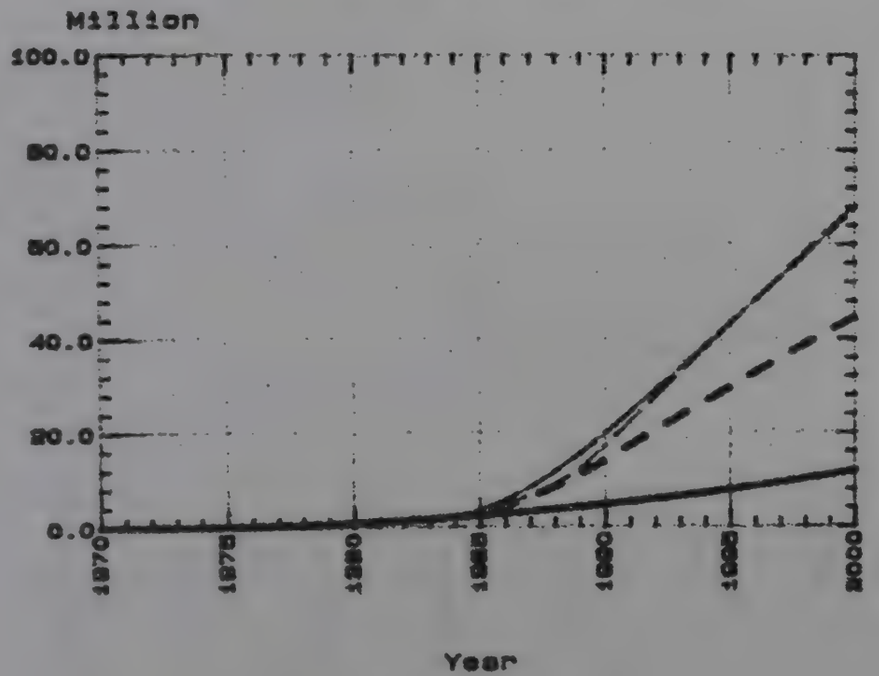
S1 -Kerala pattern of age at marriage

BR -Base Run

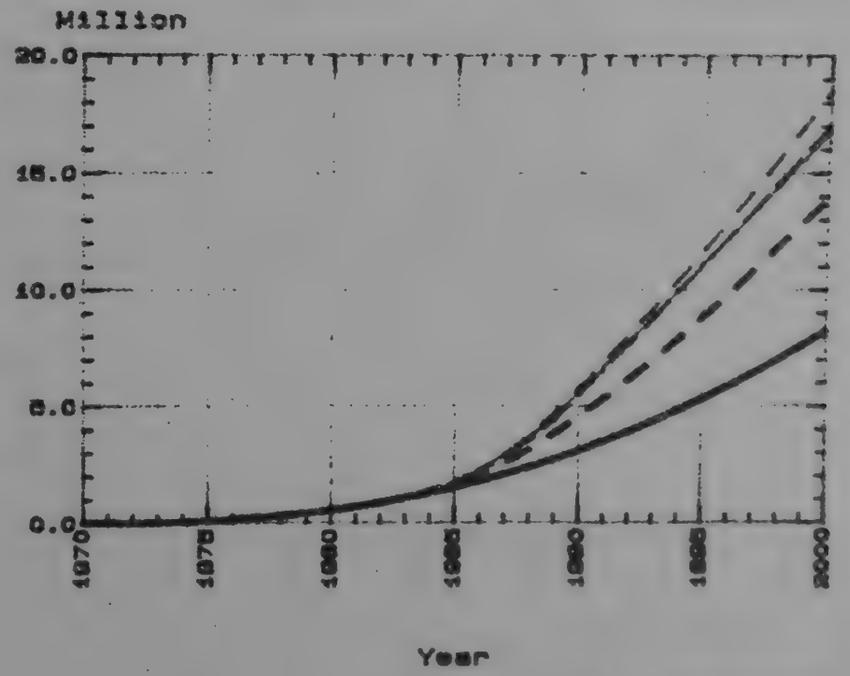
No of births averted in Urban Area
by rising age at marriage



Cumulative births averted
by rising age at marriage - Rural

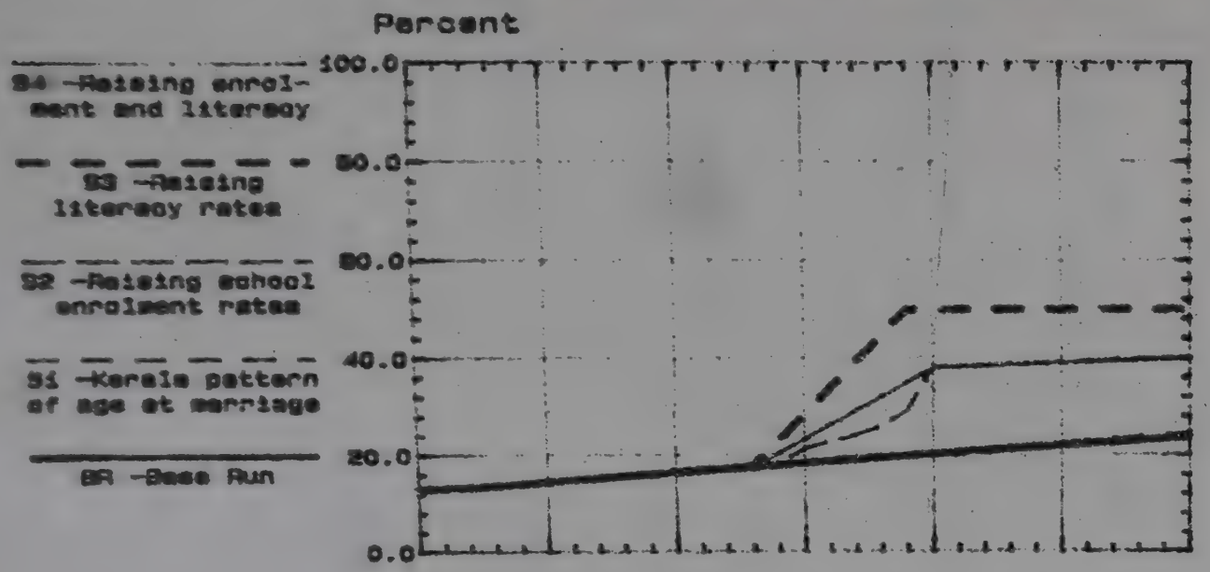


Cumulative births averted
by rising age at marriage - Urban

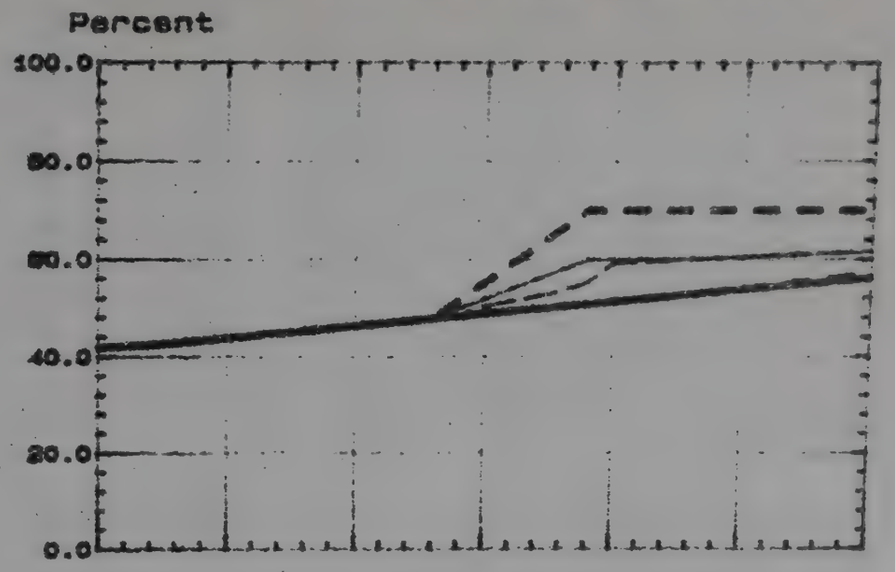


GRAPH SHEET 5.8

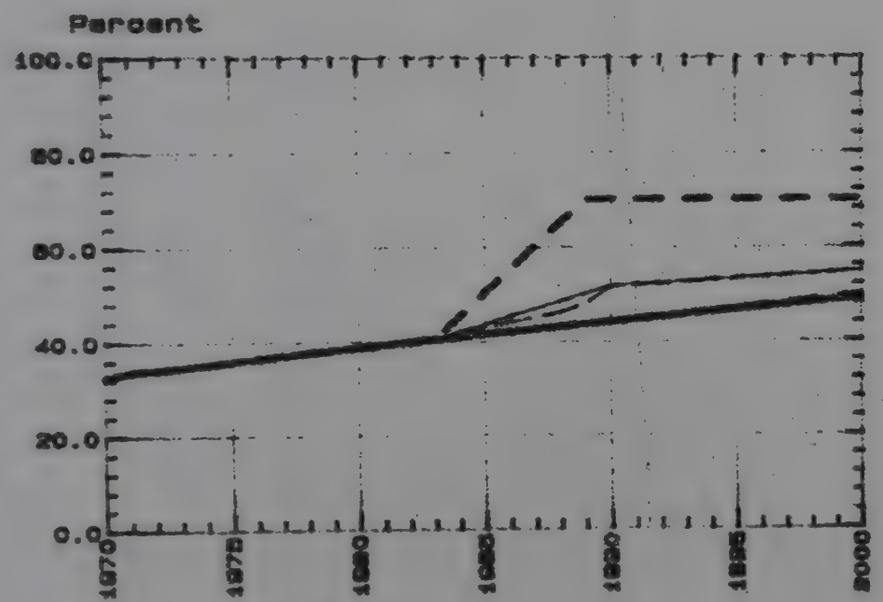
Rural Female Literacy Rate



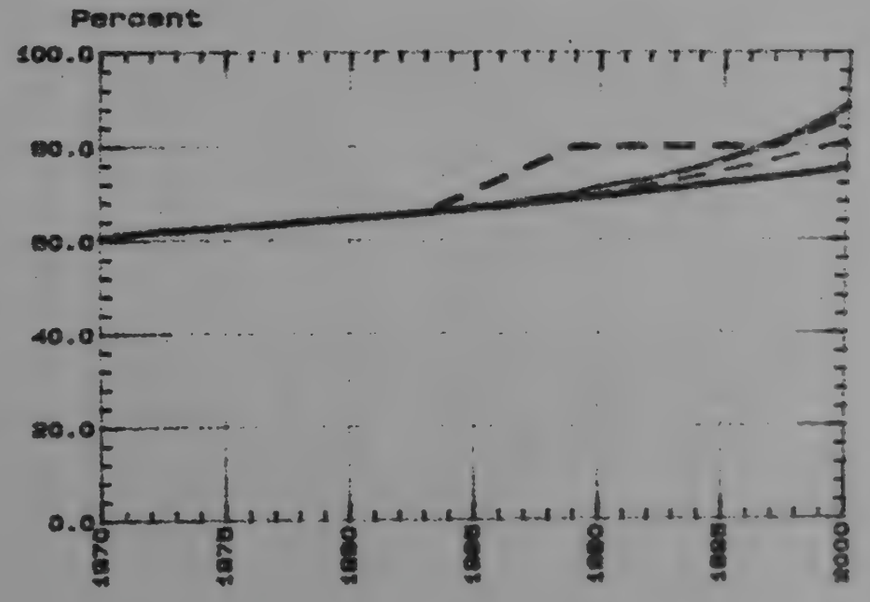
Urban Female Literacy Rate



Rural Male Literacy Rate



Urban Male Literacy Rate



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